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This curriculum guide is intended for use in an ungraded science program encompassing grades 4, 5, and 6 in elementary schools in southwestern North Dakota. The guide and a companion volume, developed for grades 1, 2, and 3, represent an attempt to develop a model science program for grades 1-6. The total program is an indepth study of 64 basic concepts from the physical and natural sciences. In this volume units on measurement, earth properties, weather, energy, the chemical world and space science are presented. Each unit is introduced with a statement of goals followed by a list of measurable objectives. Vocabulary words for each concept are also listed along with a bibliography of pertinent reading material. The appendices contain information on conducting field trips and numerous standard measurement tables. Page 20 is missing from the document. (BC)

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Instructional Media Center

Dickinson Public Schools

Dickinson, North Dakota

An Ungraded Intermediate Level Science Program

Levels Four Through Six

(Grades 4-5-6)

July, 1968

SE 007 467

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PREFACE

The following pages constitute the culmination of two years of concentrated planning and study to develop a model science program grades one through six. The program is divided into two parts probing a depth study of 64 basic concepts.

The design of instruction permits individualization thus meeting each student's need. Special stress has been made on the use of the inquiry approach and by the the extensive use of instructional media materials to give an opportunity to visualize and hear what is physically impossible to experience in the classroom.

Special materials are available to the schools served by the Instructional Media Center. These more costly materials will prove of immeasurable value in the service area and serve as a guide to other schools desiring to purchase similar items.

Credit is due to Myron Freemon and John Anderson of Dickinson State College, Professors of Biology. The basic concepts involved resulted from their study.

Editing, detailed material correlation, and the educational objectives are the work of the Instructional Media Center Curriculum Coordinator, Vernon F. Hagen. Mr. Hagen will continue to provide implementation leadership through workshops as requested by area teachers and will continue to show through evaluative techniques the affects of the approach used.

Special recognition is due Mr. George Fors, science consultant for the Department of Public Instruction, from the State of North Dakota, for his encouragement and consultive advice.

The Instructional Media Center takes great pride in making this curricular endeavor possible.

Gordon L. Paulsen, Director
July 23, 1968

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TABLE OF CONTENTS

Chapter Page

PREFACE — Gordon L. Paulsen, Director . . . i

I INTRODUCTION _ Vernon F. Hagen, Curriculum Consultant . . . 1
A Vertical Program In Science . . 6

II MEASUREMENT IN SCIENCE

Temperature 8
Time 9
Distance 10
Weight 12
Speed 13
Volume 14
Area 15

III THE EARTH AND ITS PROPERTIES

Matter 16
Minerals and Rocks 17
Water 19
Air 21
Conservation 22
Fossils 25

IV WEATHER

Weather, Measurements of Weather and Weather Forecastings 26
Climates and Seasons 29

V CHEMICAL WORLD

Atoms, Molecules and Elements 31
Common Compounds, Mixtures, Solutions and Their Formations 33
Complex Compounds, Mixtures and Solutions . 34

VI ENERGY OF LIVING THINGS

Cells 36
Organization of Cells 37
Classification of Living Organisms 39
Micro-organisms - Protista 40
Plants 42
Animals 44

VII THE ENERGY OF NON-LIVING SYSTEMS

Work 50
Electricity 51
Magnetism 53
Gravitational Energy 54
Machines 55
Light 56
Sound 58
Heat and Fire 59

VIII SPACE

Galaxies 61
Man and His Achievement in Space 61
The Future of Space 61

APPENDIX

Field Trips 69
Transparencies 71
Addresses 74
Measurement 76

CHAPTER I

INTRODUCTION

INCLUSIONS

This guide is designed "open-ended" to provide adaptation of the fine new materials that are being developed in our nationwide studies. It is especially adaptive to the Elementary Science Studies Units, OSMI, AAAS Units and Science Curriculum Improvement Studies Units. The most excellent publications by the North Dakota Department of Public Instruction are needed in providing resource materials for the pupils. Mr. George Fors, Science Consultant for the department, has developed some additional units that have much merit. Nature and Science, Ranger Rick, and Science and Children should be readily available.

The beautiful books published by Children's Press, Melmont Press, Follett Book Company, McGraw-Hill, Webster Division, and Golden Books provide endless exploratory opportunities for children. Many others, too, are outstanding. Of course, good sets of encyclopedias should be available.

The numerous basal series and accompanying kits can be used as basal texts, or the teacher can select a variety of basal texts and use all of them as reference books.

INQUIRY

By placing a variety of materials in the hands of the youngsters, they can explore the world around them. Children are scientists by disposition, they ask questions, use their senses and reasoning power to explore the physical environment. Solving problems is a challenge. They like it. Whet their natural curiosity and prick their imagination becomes the teacher's main task! Modern technology is taken "right-in-stride." From running a motion-picture projector to analyzing a growing bean plant become intriguing adventures. Exploration, experimentation, inquiry, and the use of technology are blended with a structured science program in this guide. Since no one can learn all there is to know, specially selected concepts are selected for depth study. Thus, this guide lends orderly structure. The teacher will light the torch that sends the pupil on his inquisitive way to a disciplined, manag . and satisfying life-time of exploration.

HOW CHILDREN LEARN

Jean Piaget, the famous Swiss child psychologist, discovered long ago that children learn in quite distinct stages. Children from ages seven to twelve enter the learning stage which Piaget refers to as the "concrete operations" stage. One may quarrel with the rigidity of age brackets because of individual differences of when he begins or ends the level of learning, though it is relative.

"Concrete operations" means actual reasoning carried on with things that are not too far from reality, objects and real situations. Abstractions are a much higher level of reasoning.

If one accepts the hypothesis that any subject can be taught effectively in some intellectual honest form to any child at any stage of development, then resourceful teachers will present imaginative teaching strategies to provide learning opportunities for every child.

Concept development, certainly an abstraction, then must be approached by successive concrete operations. It was the intent of this organization to approach the drafting of this study with concept formation through the development of "concrete operations," real objects, used through laboratory experiences. The guidelines are designed in this manner because the child learns most with active discovery experiences, even though teacher demonstrations may be quicker. Learning and thinking are of prime essence.

In leading the child to learn by discovery, the teacher has a vital role of acting as a catalyst of educational reaction.

LEARNING LEVELS

The guideline is designed to be used at three levels of instruction. It may be readily adapted to a graded program, but it was primarily designed for an ungraded multi-level science program for intermediate school age children.

Ungraded multi-level intermediate science program is defined to mean that the study will provide for a child of nine, ten, or eleven years of age in level four, five or six. Each level is intended to be successively more involved than the preceding level.

Teachers may select each unit for yearly exploration with emphasis to specific concepts at a given year also.

CONCEPTS

Organization of the study is focused around thirty-three major concepts in seven units of study. Each concept may be over-lapped in each successive level to provide a "spiral approach" for more inquiry into the subject matter, or it may be used selectively in a grade level.

If each concept is studied for one week, then thirty-three weeks will be used to teach the course. The teacher must use her own discretion as to the proper use of time and the selections of concepts for emphasis.

GOALS AND OBJECTIVES

General goals and measurable behavioral objectives have been incorporated into the structure of this guide. The intent of the behavioral objectives is to provide the teacher with a criteria expectation of minimal terminal performance. The general goals relate a general outline of expectations.

The teacher must not feel obliged to accept the behavioral objectives as the only behavioral performance to expect from each child. "Reasonableness!" the reasonable, prudent teacher must prevail. Exciting, yes! but prudent! The frame-work by which teachers will stimulate children to an enriched understanding is provided rather than a frame-work to create scientific prodigies.

PURPOSE

The Instructional Media Center has, as one of its objectives, the development of a model science program.

Extensive audio-visual materials are "cross-referenced" with each unit of the guideline. The audio-visual materials are available to participating schools through the Instructional

Media Center. The Center will provide the audio-visual materials; schools must provide the library and reference books.

By joining concrete teaching strategies with extensive audio-visual materials, fine reference books, curious imaginative youngsters and enthusiastic, inspiring teachers, learning and thinking ought to occur.

Vernon F. Hagen
Curriculum Coordinator

Moan somewhere else, text-creepers.

Theodore Roethke

I can find the answer, but what's the question? The school day is spent not in scurrying after "right" answers, but in searching for interesting questions and suggestions for the pursuit of their solutions.

Dr. Lazer Goldberg

DEPARTMENT OF PUBLIC INSTRUCTION
M. F. Peterson, Superintendent
Bismarck, North Dakota

A VERTICAL PROGRAM IN SCIENCE

Grade				
12	Physics	Could Include or Become PSSC-Type Program		
11	Chemistry	Could Become Chem Study or CBA Types		
10	Biology	Could Become BSCS Type Program		
9	Physical Science	Lab. Procedures, Measurement, Machines, Sound, Light, Heat, Chem., Electricity		
8	Earth Science	Astronomy and Space	Meteorology	Geology
7	Life Science	Living Things, Agriculture, Conservation	Human Body	
6	Living Things	Sky	Earth	Matter & Energy
5	Living Things	Sky & Earth		Matter & Energy
4	Living Things	Sky	Earth	Matter & Energy
3	Living Things	Above the Earth	Earth	Matter & Energy
2	Living Things	Above the Earth	Earth	Matter & Energy
1	Living Things	Above the Earth	Earth	Matter & Energy

Blocks of time are suggestive for Grades 1-8.

—Harald N. Bliss, Science Consultant

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CHAPTER II

MEASUREMENT IN SCIENCE

Goals

To involve and develop the pupil in:

1. the methods by which measurements are made.

2. the many systems by which measurements are recorded.

3. the manner by which measurements assist to develop and explain the predictability of science based on measurements.

Measurable Objectives

1. Given specific numerical readings, the pupil will demonstrate his competency in measurement proficiency and understanding by making at least ten different measurements with a variety of media in the following areas: temperature, time, distance, weight, speed, volume, and area. He shall make measurements using the English System of measurement and the metric systems. Ninety percent accuracy will be minimal performance.

2. The pupils will demonstrate their understanding of the importance of accuracy in measurement by making comparative measurements both accurately and inaccurately showing the results in the performance of measurements.

    a. Demonstrations may be done to demonstrate the importance of accuracy by:

        (1) Adding sugar to squeezed lemon, too much, too little, just right.

        (2) Aiming a rifle at the target; off bull's eye, on bull's eye.

            (a) Projecting results: if grizzly bear? bull elephant?

    b. The pupil may cite examples where measurement accuracy means the difference between success and total failure:

        (1) Aiming of guided missiles in space.

        (2) Typing of instructions in medicine.

        (3) Inaccuracy of measurement of certain lethal medicines.

        (4) Others.

3. Given a sampling of fifty terms, the pupil will define, use in proper context, and spell the terms with ninety percent accuracy.

Temperatures

Measurable Objectives

4. Given seven specific centigrade (Celsius) and Fahrenheit scale temperature readings, the pupil will show his competency by reading the scales accurately.

5. Given specific readings, the pupil will read a thermometer to differentiate degrees minus zero and plus zero accurately (simulated weather conditions) at various readings using the metric (Celsius) scale and the Fahrenheit scale.

6. Given the body temperature readings of humans and body temperatures of birds, reptiles, and other cold blooded animals, the pupil will measure the correct variances in temperature.

7. Given the materials, the pupil will measure the melting point of solid water, milk, cheese, plastic, rubber, styro foam, rayon, nylon, ice cream, sugar, salt, parafin (wax), Coca Cola, and Squirt as accurately as his instruments can measure.

8. Given the materials, the pupil will measure with relative accuracy the solidifying state (freezing point) of: water, wax, salt water, ice cream, Coca Cola, and Squirt.

Vocabulary--Some Specific Words

absolute zero
cryogenics
freezing
heat
liquid air
melting point
thermodynamic
thermograph
thermostat
B.T.U.

Temperature Outline References

Books:

Bond, Austin D. *Experimenting In Science #4*, Chicago: Lyons and Carnahan, 1963, pp. 220--see pages 146-157.

Katz, Morris, *Science Through Discovery #5*, New York: L. W. Singer Company, 1968, pp. 336--see page 160, Unit 5.

*Novak, Joseph D. The Orderly World of Science #5, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 8-16.

Rockcastle, Verne, Manual For Measurement of Science, Union, New Jersey: Ohaus Scale Corporation, 1965, pp. 64.

*Schmidt, Victor E. and Rockcastle, Verne, Teaching Science With Everyday Things, St. Louis: McGraw-Hill Book Co. 1968, pp. 167.

Smith, Herbert A. Science #4, River Forest, Illinois: Laidlaw Brothers, 1966, pp. 288--see page 196.

Tannenbaum, Harold E. Teachers Manual for Heat, Experiences in Science Publication Series, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Tannenbaum, Harold E. Teacher's Manual for Hot and Cold, Experiences in Science Publication Series, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Weisbuch, Fred T. Patterns and Processes of Science, Boston: D. C. Heath Company, 1968, pp. 531--see pages 433-453.

Films:

"Heat and How We Use It" EBF, B/W, 11 min. IMC #439.

Time

Measurable Objectives

1. The pupil will demonstrate his competency in time measurement by reading five different time settings accurately on a standard clock.

2. The pupil will demonstrate his competency in time measurement by giving the difference accurately in time in hours between Greenwich, England and three select cities in the world.

3. The pupil will demonstrate competency in time measurement by reading a calendar and ascertaining accurately the minutes, hours, weeks, and months between two specific dates assigned by the teachers.

Plain speech is inaccurate, but not plain words.

Theodore Roethke

4. The pupil will accurately demonstrate by recitation or in written form, his rote learning of the standard time units. (example: 60 seconds equals one minute through and to include decades and centuries.)

Vocabulary--Some Specific Words

time zones
$24 X 15^\circ = 360^\circ$
calendar
clock

Greenwich Meridian
hour
meridian
moment

month
Standard Time
week
year

Time Outline References

Books:

Jacobson, Willard J. Inquiring Into Science #3, New York: American Book Co. 1968, pp. 125--see pages 243-268.

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pages 397-428.

Novak, Joseph D. The Expanding World of Science #4, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 19-27.

Rockcastle, Verne, Manual for Measurement of Science, New Jersey: Ohaus Scale Corporation, 1965, pp. 64.

Tannenbaum, Harold E. Teacher's Manual for Time, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Films:

"How to Measure Time" EBF, B/W, 11 min. IMC #451.

Distance

Measurable Objectives

1. The pupil will demonstrate his knowledge of measuring systems, both English and metric system, by measuring accurately surface lengths, surface areas, and cubic volumes provided by the teacher.

2. The pupil will demonstrate his understanding of distance, the amount of space between two places, in illustrating units of measure by converting a known distance specified by the instructor, to at least ten different units of measure at 85% accuracy.

3. The pupil will demonstrate, in narrative form, his knowledge of the historical development of measurement. Eighty percent proficiency is a minimum score.

4. The pupil will compute the time-distant relationship in traversing the earth at the equator and make a comparative computation in traversing space to our moon and other planets.

5. The pupil will demonstrate his understanding of speed (rate) time relationship in traversing distance by computing accurately time and speed needed to traverse a known specified space.

6. The pupil will recite accurately the standard scaling of the English and metric system of measurement in distances.

7. The pupil will demonstrate his understanding of degrees and meridian in globe measurement by solving a simulated problem, determining how many miles at the earth's equator each degree represents. The sophistication of the problems must be at the child's learning level.

8. The pupil will demonstrate his knowledge and manipulation of the ruler by ascertaining the equal spacings in fraction of inches, inches, and feet of markings for a grid. A simulated cattle crossing may be developed, pleats in a skirt or similar problems may be made to test the child.

Vocabulary--Some Specific Words

metric-units of 10
English System
bases of unit
standard of measure
Bureau of Standards

inch
foot
yard
rod

fathom
centimeter
distance
hand

Distance Outline References

Books:

Jacobson, Willard J. Inquiring Into Science #3, New York: American Book Co. 1968, pp. 125--see pages 243-268.

And a little child shall lead us--unless we don't want to go. If you feel about school the way you did when you settled down in kindergarten, you're doing well and so am I. If you've learned to play the con game, school has failed you and I had better do something.

Dr. Lazer Goldberg

Katz, Morris, Science Through Discovery #6, New York: L. W. Singer Company; 1968, pp. 336--see pages 145-183.

Novak, Joseph D. The Expanding World of Science, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 28-34.

Rockcastle, Verne, Manual for Measurement of Science, New Jersey: Ohaus Scale Corporation, 1965, pp. 64.

*Schmidt, Victor E. and Rockcastle, Verne, Teaching Science With Everyday Things, St. Louis: McGraw-Hill Book Co. 1968, pp. 167.

Tannenbaum, Harold E. Teachers Manual for Unbalanced Forces, Experiences in Science Series, St. Louis: Webster Div. McGraw-Hill Book Co. 1967.

Library Books:

Friskey, Margaret, About Measurement, Chicago: Melmont Publishers, Inc. 1965, pp. 31.

Weight

1. The pupil will demonstrate his understanding of the metric system of weight measurement by reciting accurately, orally or in writing, the system from the smallest unit through the largest unit in consecutive order.

2. The pupil will demonstrate his knowledge of the metric system by weighing as accurately as his instruments can measure, three different objects or things designated by the teacher.

3. The pupil will illustrate his understanding or "an object weighs less and less, the farther it leaves the center of the earth" by citing illustrations of simulated or real situations.

Vocabulary--Some Specific Words

English System of Measurement
Avoirdupois Weight (lb. - oz.)
mass-metric
weightlessness
assay ton
bolt
butt
knot-1 nautical mile per hour
line-140"
load-1 cu. gal.
nail-2.25
palm-3" or 4"
perch-24.75 cu. ft.
pin-4½ gal.
pipe-126 gal.
carot
catty
chaldron
cubit
ell
firkin-56 lb.
fortnight
hogshead
kilderkin-18 gal.

Weight Outline References

Books:

Katz, Morris, *Science Through Discovery #6*, New York: L. W. Singer Company, 1968, pp. 336--see pages 140-144.

Novak, Joseph D. *The Expanding World of Science*, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 37-39.

Novak, Joseph D. *The Orderly World of Science*, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 8-17.

Rockcastle, Verne, *Manual for Measurement of Science*, New Jersey: Ohaus Scale Corporation, 1965, pp. 64.

*Schmidt, Victor E. and Rockcastle, Verne, *Teaching Science With Everyday Things*, St. Louis: McGraw-Hill Book Co. 1968, pp. 167.

Smith, Herbert A. *Science #6*, River Forest, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 179-181.

Tannenbaum, Harold E. *Teacher's Manual for Balances*, Experiences in Science Series, St. Louis: Webster Division, MdGraw-Hill Book Co. 1967.

Weisbuch, Fred T. *Patterns and Processes of Science*, Boston: D. C. Heath Company, 1968, pp. 531--see pages 255-260.

Films:

"Forces of Gravity" McGraw-Hill Film Co. B/W, IMC #765.

"Gravity: How it Affects Us" EBF, Color, IMC #252.

Speed-Velocity-Motion

Measurable Objectives

1. Given the concepts listed below, the pupil will demonstrate his understanding by explaining the terms, orally or in writing with at least eighty percent accuracy.

   a. Motion occurs when an object changes position in space.

   b. Motion is a relative term rather than an absolute term.

c. Velocity is the speed, or how fast an object moves.

d. Velocity is a term referring to how fast an object moves in a straight line.

e. Speed refers to how fast an object moves in rectilinear motion or curvilinear motion as the case may be.

f. When the velocity of a moving object is constant, the motion is said to be uniform, when it is not it may be variable.

g. Inertia is the property of matter that resists change in motion.

Vocabulary--Some Specific Words

acceleration
deceleration
momentum
velocity-speed
momentum-kinetic energy
impact
inertia

Speed-Velocity-Motion Outline References

Books:

Katz, Morris, Science Through Discovery #6, New York: L. W. Singer Company, 1968, pp. 336--see pages 145-149.

Novak, Joseph D. The Expanding World of Science, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 35-37.

Volume

Measurable Objectives

1. The pupil will learn the scientific definition of volume, "Volume is the space within something occupied by the something" so that he can write or say it verbatim.

2. The pupil will learn the meaning of volume well enough so that he can measure the cubic inches or cubic centimeters of three objects selected by the teacher.

3. The pupil will demonstrate his understanding of volume by ciphering the correct volume of a six inch rubber ball.

4. The pupil will demonstrate his understanding of volume by listing the correct formula for deciphering the volume of a cube, a cone, and a pyramid, then measuring correcty the volume of select containers.

Vocabulary--Some Specific Words

sphere	rectangle	cylinder
cone	log	pyramid

Volume Outline References

Books:

Novak, Joseph D. The Expanding World of Science, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 39-45.

Rockcastle, Verne, Manual for Measurement of Science, New Jersey: Ohaus Scale Corporation, 1965, pp. 64.

Schmidt, Victor E. and Rockcastle, Verne, Teaching Science With Everyday Things, St. Louis: McGraw-Hill Book Co. 1968, pp. 167.

Weisbuch, Fred T. Patterns and Processes of Science, Boston: D. C. Heath Company, 1968, pp. 531--see page 248.

Area

Measurable Objectives

*Area: The surface of a space or thing.

1. The pupil will demonstrate his understanding of "area" by measuring a prescribed plane accurately.

2. Given a cube, the pupil will measure accurately the surface area in either Celsius or Fahrenheit scale.

Area Outline References

Books:

Novak, Joseph D. The Expanding World of Science, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 39-42.

Rockcastle, Verne, Manual for Measurement of Science, New Jersey: Ohaus Scale Corporation, 1965, pp. 64.

Play is so important you might think it will appear on the achievement test.

Dr. Lazer Goldberg

CHAPTER III

THE EARTH AND ITS PROPERTIES

Subtopics of the Earth

1. Matter
2. Minerals and Rocks
3. Water and its Properties
4. Air and its Properites
5. Conservation
6. Fossils

Goals

To acquaint the pupils with:

1. The composition of the earth.
2. The ever-changing surface of the earth.
3. The distinct properties of the earth.
4. Prehistoric life recorded in the earth.
5. Conserving the materials within and of the earth.
6. Interaction of the earth and the material that surrounds it.

Matter

Measurable Objectives

1. Given fifty select scientific words applicable to this unit, the pupil will define them accurately using root derivations. He will spell the words with a minimum of eighty percent correctness.

2. The pupil will be able to draw the crust, mantle, core, and atmosphere of the earth in a colored cross-section illustration, listing the relative properties of each layer. Eighty-five percent accuracy is acceptable.

3. Given samples of liquids, solids, and gases, the pupil will identify each and write the distinct properties of these forms of matter.

4. Given two select compounds, the pupil will make colored illustrated drawings showing the atomic arrangement; specific elements will be color-coded to distinguish them from other atoms. Ninety percent accuracy is minimal.

5. The pupil will relate matter to energy and motion by writing a narrative discussion of this relationship. Seventy-five percent proficiency will be considered acceptable.

6. Given a model of the universe, the pupil will demonstrate the earth's perpetual change in its relationship to the galaxy. Eighty percent accuracy is minimal.

Matter Outline References

Books:

Jacobson, Willard J. Probing Into Science #4, New York: American Book Company, 1968, pp. 304--see pages 99-114.

Novak, Joseph D. The Expanding World of Science, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 46-49.

Smith, Herbert A. Science #6, River Forest, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 176-215.

Weisbuch, Fred T. Patterns and Processes of Science, Boston: D. C. Heath Company, 1968, pp. 531--see pages 253-343.

Tapes:

"Look Inside the Earth" Imperial Productions Inc. 1965, IMC #T-73.

"Liquids, Solids, and Gases" Imperial Productions Inc. 1965, IMC #T-72

Minerals and Rocks

Measurable Objectives

1. The pupil will demonstrate his understanding of the minerals of the earth by naming at least four specific minerals, giving their properties and illustrating how he can test the mineral to determine its property. He may use the color, streak, luster, hardness, texture, crystal structure, cleavage or fracture tests or a combination of these tests to determine the mineral's properties.

> Errors make the heart grow fonder. All honest errors are respected. Interesting errors are admired. Children who are rarely wrong, rarely dare ideas that are their own.
>
> Dr. Lazer Goldberg

2. Given fifteen select samples of rocks; the pupil will classify, with eighty percent proficiency, samples into the categories; igneous, sedimentary, and metamorphic rocks.

3. The student will demonstrate his knowledge of rock formation classification by identifying at least three igneous, three sedimentary, and three metamorphic rocks and correctly giving them their common names.

4. The pupil will demonstrate his understanding of rock formation classification by telling, or in written form, how each of these three groups of rocks are developed and what their basic characteristics are. Eighty percent proficiency is minimal.

Minerals and Rocks Outline References

Books:

Bond, Austin D. Living With Science, Chicago: Lyons and Carnahan, 1963, pp. 287--see pages 210-220.

Jacobson, Willard J. Probing Into Science #4, New York: American Book Company, 1968, pp. 304--see pages 31-42.

Katz, Morris, Science Through Discovery #4, New York: L. W. Singer Company, 1968, pp.336--see pages 38-75.

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pages 232-284.

Novak, Joseph D. The Expanding World of Science, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 243-252.

Smith, Herbert A. Science #4, River Forest, Illinois: Laidlaw Company, 1966, pp. 288--see pages 97-109.

Tannenbaum, Harold E. Teacher's Manual for Geologic Processes, a National Science Teachers Association Publication, St. Louis: McGraw-Hill Book Co. 1967.

Teachers Publishing Corporation, The Earth, Darien, Conn: The Corporation, National Science Teachers Publication, pp. 94--see pages 10-39.

Films:

"Minerals and Rocks" EBF, Color, 16 min. IMC #69.

"Rocks that Form on the Earth's Surface" EBF, Color, 16 min. IMC #57.

"Rocks that Form Under the Ground" EBF, B/W, 23 min. IMC #58.

"Treasures of the Earth" Churchill Films, Color, 11 min. IMC #783.

Tapes:

"Let's Find Out About the Land Around Us" Imperial Productions Inc. 1965, IMC #T-45.

"Minerals Around Us" Imperial Productions Inc. 1965, IMC #T-74.

Water

Measurable Objectives

1. The pupil will demonstrate his understanding of water, its common usages in the many life processes and its function in the scheme of the universe by giving at least ten distinct uses taken from the accompanying illustration "Conservation and the Water Cycle." Ninety percent proficiency will be acceptable performance.

2. Given a water sample, the pupil will demonstrate vicariously how water changes its form in condensation, evaporation and freezing. He will show water characteristics such as surface tension, buoyancy, its refrigeration effect, its solvency, freezing, boiling points, by meeting minimum teacher criteria with seventy-five percent accuracy.

3. Without references the pupil will show, by illustration, his understanding of the water cycle. Seventy-five percent accuracy is minimal.

Measurableness is not next to godliness. The most important developments in children are not necessarily those that are clearly measurable, and public measurments are rare.

Dr. Lazer Goldberg

Water Outline References

Books:

Bond, Austin D. Experimenting In Science, Chicago: Lyons and Carnahan, 1963, pp. 220--see pages 192-199.

Bond, Austin D. Looking Ahead With Science, Chicago: Lyons and Carnahan, 1963, pp. 287--see pages 256-259.

LaMotte Chemical Products Co. A Study of Water Quality, Chestertown, Maryland: The Company, 1966, pp. 23.

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pages 184-200.

Novak, Joseph D. The Expanding World of Science, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 213-225.

Tannenbaum, Harold E. Teachers Manual for Solids, Liquids, and Gases, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Teachers Publishing Corporation, The Earth, A National Science Teachers Association Publication, Darien, Conn: The Corporation, pp. 94--see pages 38-61.

Films:

"Water and What it Does" EBF, B/W, 11 min. IMC #440.

Tapes:

"Let's Find Out About Water" Imperial Productions Inc. 1965, IMC #T-41.

"Water, The Giver of Life" Imperial Productions Inc. 1965, IMC #T-67.

Air

Measurable Objectives

1. The pupil will demonstrate, in writing or orally, his understanding of air by showing that air occupies space, has weight and flows. Ninety percent proficiency is minimal acceptancy.

2. The pupil will show as accurately as possible by graphs what the normal contents of air at sea level in Los Angeles is.

3. The pupil will demonstrate what effect air polution has on living things by a simple demonstration such as filling a compartment with smoke, or some other noxious gases.

4. The student will show with accurate graphs the layers of air in the atmosphere.

5. Given the term "biosphere," the pupil will illustrate it accurately and describe it in general terms.

Air Outline References

Books:

Bond, Austin D. Looking Ahead With Science, Chicago: Lyons and Carnahan, 1963, pp. 287--see pages 182-200.

Katz, Morris, Science Through Discovery #6, New York: L. W. Singer Company, 1968, pp. 336--see pages 234-263.

Novak, Joseph D. The Expanding World of Science #4, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 81-90.

Novak, Joseph D. The Orderly World of Science, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 236-242.

Films:

"Air and What it Does" EBF, B/W, 11 min. IMC #434.

Tapes:

"The Atmosphere" Imperial Productions, Inc. 1965, IMC #T-65.

"Let's Find Out About Air" Imperial Productions, Inc. 1965, IMC #T-44.

Conservation

Measurable Objectives

1. The pupil will demonstrate his knowledge of how living things are dependent on each other and their environment by setting up six hypothetical situations or simulated experiences of each, living and non-living things, in which living and/or non-living things become "out of balance" with one another. He will perform with ninety percent accuracy as minimum performance based on teacher criteria. (Interaction) see SCIS' Interaction, Teachers Guide D. C. Heath 1968 listed in the reference section of this unit.

Transcend that vision. What is first or early is easy to believe. But . . . it may enchain you.

Theodore Roethke

2. Given six plants and six animals, the pupil will demonstrate his knowledge of "adaptation" by citing the adaptation of each and illustrating accurately how the adaptations have effected the life of the plant or animal. Ninety percent proficiency is acceptable performance.

3. The pupil will demonstrate his understanding of the necessity of good soil conservation practices by citing three examples in narrative or oral report, with supporting evidence using graphs, pictures, and other materials. He will show what poor conservation has done within the locality also. Eighty percent proficiency is acceptable.

4. The pupil will demonstrate his understanding of good forest and soil conservation practices by citing the results of past practices indicating what has happened to northern Minnesota forests, and of select wheat fields of North Dakota. Seventy-five percent accuracy is expected.

5. The pupil will demonstrate his knowledge of ecosystems by giving a written report of his observation of an aquarium ecosystem or a terrarium ecosystem. Eighty percent accuracy is minimum performance. Relationship will be drawn to natural ecosystems.

6. The pupil will demonstrate his understanding of the different periods of the geographic time chart by putting a selected mixed assortment of fossils in their respective categories of origin: cenozoic, mesozoic, paleozoic, or pre-cambrian. Seventy-five percent accuracy is minimum acceptable performance.

OK

7. Given 25 select words, the pupil will demonstrate his understanding of scientific terms by spelling and defining the terms. He will relate the terms to their proper usage; understand the root words and demonstrate that understanding by converting the root (foreign) to common English translation. Eighty percent accuracy is an acceptable level of performance.

Conservation Outline References

Books:

Blough, Glenn, Science is Experimenting, Basic Science Program #4, Chicago: Scott, Foresman and Company, 1965, pp. 240--see pages 122-129.

Bond, Austin D. Looking Ahead With Science, Chicago: Lyons and Carnahan, 1963, pp. 287--see pages 241-270.

Dietrich, Irvine T. and Hove, John, Conservation of Natural Resources in North Dakota, St. Paul: Webb Publishing Co. 1962, pp. 327.

Katz, Morris, Science Through Discovery #5, New York: L. W. Singer Company, 1968, pp. 336--see pages 138-163.

Katz, Morris, Science Through Discovery #6, New York: L. W. Singer Company, 1968, pp. 336--see pages 264-303.

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pages 319-362.

North Dakota Department of Public Instruction, Elementary Science Source Book I, The Department, pp. 283--see pages 1-59.

Novak, Joseph D. The Orderly World of Science, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 253-259.

*Science Curriculum Inprovement Study, Interaction, Teachers Guide, Boston: D. C. Heath and Co. 1968, pp. 104.

Tannenbaum, Harold E. Teacher's Manual for Ecology, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Films:

"Desert Community" EBF, B/W, 12 min. IMC #483.

"Life In The Forest" EBF, Color, 11 min. IMC #230.

"Life In The Grasslands" EBF, Color, 11 min. IMC #231.

"Life In The Sea" EBF, Color, 11 min. IMC #501.

"Life In The Tundra" EBF, B/W, 14 min. IMC #492.

"Life In A Vacant Lot" EBF, Color, 11 min. IMC #565.

"The Marsh Community" EBF, Color, 11 min. IMC #117.

Filmstrips:

"Conserving Our Natural Resources" EBF, Color, IMC #FS-207.

"Forests of Tropical America" EBF, Color, IMC #FS-185.

"Natural Resources and You" EBF, Color, IMC #FS-217.

"Using Natural Resources" EBF, Color, IMC #FS-218.

Multi-Media Kits:

"Conservation for Today's America" Society for Visual Education, IMC #M-42.

Fossils

Measurable Objectives

1. Given eight prehistoric creatures, as examples, the pupil will be able to identify accurately each in the time charts of history.

2. Given eight prehistoric animals or plants, as examples, the pupil will classify six of them as to their scientific classification, giving reasons why the plants or animals are classified as they are and giving a brief summary of each one's activities as a living thing. Based on teacher's evaluation, eighty percent accuracy is minimal.

3. Given the period charts placed in scrambled order, the pupil will place them accurately in proper order listing the approximate dates when each prehistoric time period existed.

4. Given a list of twenty prehistoric animals, the pupil, without references, will be able to select one and give at least a two minute report with reasonable accuracy.

Fossils Outline References

Books:

Blough, Glenn, Science is Adventuring #6, Chicago: Scott, Foresman and Company, 1965, pp. 240--see pages 258-288.

Jacobson, Willard J. Probing Into Science #4, New York: American Book Company, 1968, pp. 304--see pages 49-96.

Katz, Morris, Science Through Discovery #5, New York: L. W. Singer Company, 1968, pp. 336--see pages 76-111.

North Dakota Department of Public Instruction, An Elementary Science Source Book, Vol. one, The Department, 1963, pp. 255--see pages 139-165.

Novak, Joseph D. The Expanding World of Science, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 153-170.

Smith, Herbert A. Science #5, River Forest, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 84-111.

Teacher's Publishing Corporation, The Earth, A National Science Teachers Association Publication, Darien, Conn: The Corporation, pp. 94--see page 90.

I dream of a culture where it is thought a crime to be dull.

Theodore Roethke

CHAPTER IV

WEATHER AND CLIMATE

Subtopics of Weather and Climate

1. Weather and energy changes
2. Measurements of weather changes
3. Weather forecasting
4. Climates
5. Environments

Goals

To provide the pupils with a rich background of:

1. What weather and climate are, how they result from the interaction of air, water, and energy.

2. Continual weather changes often are sudden and destructive.

3. That weather predictions are based on the interaction of the elements of weather.

4. The effect that weather and climate have on the activities of man and other organisms.

Measurable Objectives

See Water Cycle sheet, Department of Agriculture, page 20.

1. Given a blank sheet of paper, the pupil will illustrate the water cycle from a beginning point at the ocean. He will trace the water cycle to plants, animals, and man's use.

2. Given a container of water and a container of earth, the pupil will show by example and describe what effect the sun's rays, its absorption has on surfaces, such as lake bodies, lake regions, desert areas, and plains regions. Eighty percent accuracy is acceptable.

3. Given twenty-five select scientific terms of this unit, the pupil will spell and define the terms with eighty percent accuracy.

Science is mostly verb and little noun. As with most verbs, there is feeling associated with it.

Dr. Lazer Goldberg

4. Given an aneroid barometer and a mercury barometer, the pupil will measure the atmospheric pressure at twenty-four hour intervals for four consecutive days and predict weather changes. He will state his reasons for his predictions. Proficiency levels will be ascertained by the teachers.

5. Given a weather map, the pupil will read the readings of the map with ninety percent accuracy explaining lows, highs, and the meaning of the symbols.

6. Having seen a convection current detector placed over a light bulb and observing the pan raise; then having seen the detector placed over a pan of ice cubes, the pupil will correlate his observation with the observations he has previously made using cold and warm fronts to describe how weather conditions change, move, and vary. (See page 28)

Weather Outline References

Blough, Glenn D. Basic Science Program #5, Chicago: Scott, Foresman and Company, 1965, pp. 240--see pages 17049.

Fischler, Abraham S. Science/A Modern Approach #5, New York: Holt, Reinhart and Winston Inc. 1966, pp. 336--see pages 6-87.

Katz, Morris, Science Through Discovery #6, New York: L. W. Singer Company, 1968, pp. 336--see pages 184-233.

May, Julian, Weather, Chicago: Follett Publishing Company, 1966, pp32.

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pages 429-442.

Novak, Joseph D. The Expanding World of Science, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 98-132.

*Schmidt, Victor E. and Rockcastle, Verne, Teaching Science With Everyday Things, St. Louis: McGraw-Hill Book Co. 1968, pp. 167.

Smith, Herbert A. Science #6, River Forest, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 115-131.

Tannenbaum, Harold E. Teachers Manual for Atmosphere and Weather, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Tannenbaum, Harold E. Teachers Manual for Weather, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Teachers Publishing Corporation, The Earth, Darien Conn: The Corporation, pp. 94--see pages 62-82.

Films:

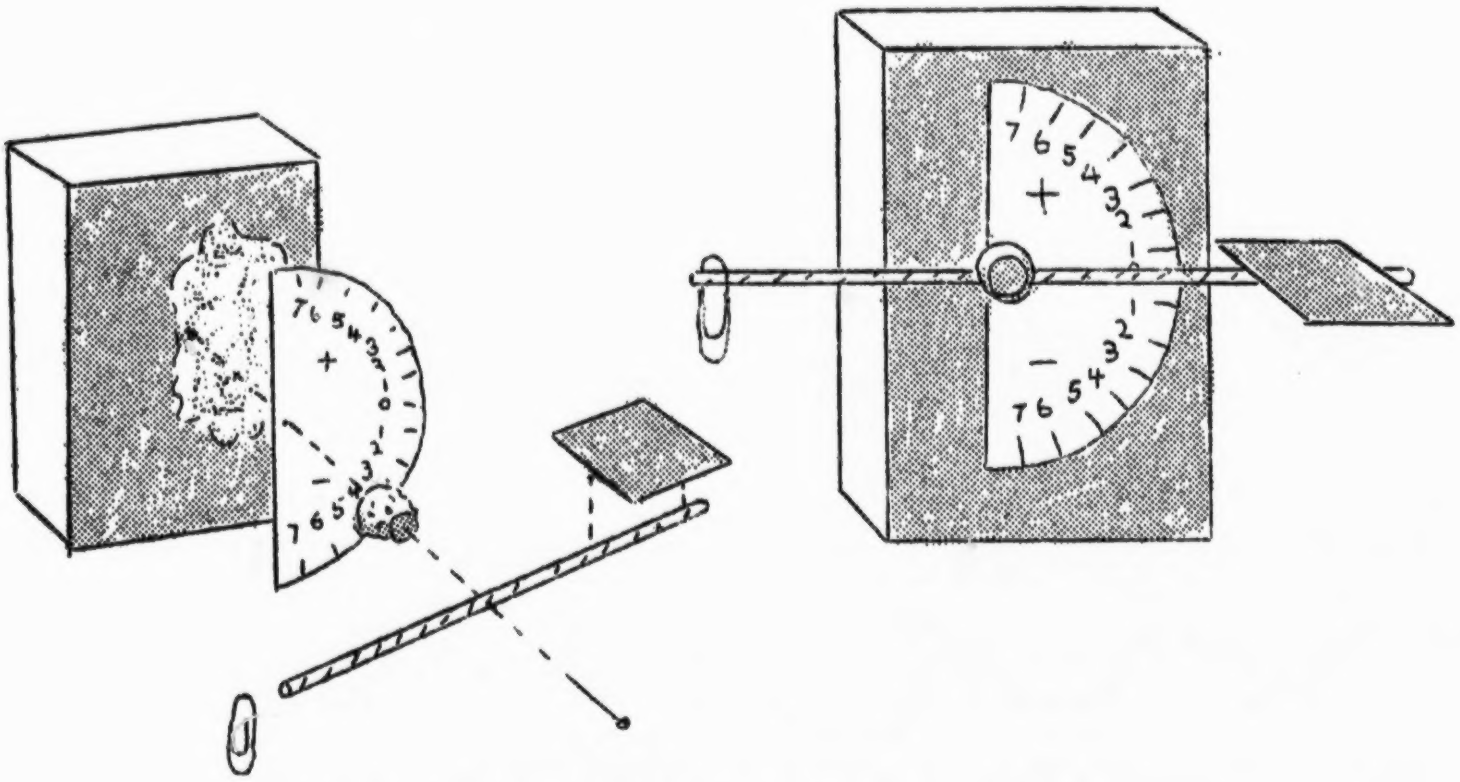
"Our Weather" EBF, B/W, 11 min. IMC #263.

"What Makes Clouds" EBF, Color, 19 min. IMC #65.

"Wind and What It Does" EBF, B/W, 11 min. IMC #448.

Tapes:

"What is Weather" Imperial Productions, Inc. 1965, IMC #T-62.



A CONVECTION CURRENT DETECTOR

Climate and Seasons

Measurable Objectives

1. Given a specific date, May 15th, the pupil will describe the kind of weather to be expected, the approximate temperature and give his reasons for such a prediction. Eighty percent proficiency is acceptable.

2. Given the four seasons, the pupil will describe why each season has its normal climatic conditions.

3. Given the temperature reading of Fairbanks Alaska, Dickinson, North Dakota, El Paso, Texas, and Mexico City on a given day, the pupil will explain the reasons for the variances in temperature.

4. Given a tennis ball, a knitting needle, and a flashlight, the pupil will demonstrate why the light of day lasts longer in summer than in winter in the northern hemisphere. Ninety percent accuracy is minimal.

5. Shown a hill and valley facing north and south, the pupil will explain why different plants live on one side of the hill while other plants live on the other side of the hill, why some live on hill-tops while others live in the valley or ravine. Ninety percent accuracy is minimal.

Climate and Seasons Outline References

Books:

Fischler, Abraham S. Science/A Modern Approach #5, New York: Holt, Reinhart and Winston Inc. 1966, pp. 336--see pages 70-79.

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pages 443-450.

Novak, Joseph D. The Expanding World of Science, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 133-136.

Films:

"The House of Man, Our Changing Environment" EBF, Color, 17 min. IMC #323.

Art is mostly feeling. As with most feeling there is thought associated with it.

Dr. Lazer Goldberg

"Why Seasons Change" EBF, B/W, 11 min. IMC #590.

Tapes:

"How Animals Fit Their Climates" Imperial Productions, Inc. 1965, IMC #T-63.

What appears to have happened depends on who tells it. This is true of history.

Dr. Lazer Goldberg

Give me the madman's sudden insight and the child's spiritual dignity.

Theodore Roethke

Play with it--if you know what I don't mean. The language has its cusses and fusses just like us.

Theodore Roethke

CHAPTER V

THE CHEMICAL WORLD

Subtopics of The Chemical World

1. Atoms, molecules, and elements
2. Common compounds, mixtures, and solutions
3. Formation of compounds, mixtures, and solutions
4. Complex compounds, mixtures, and solutions

Goals

To acquaint the pupil with:

1. The basic concept of matter composition.

2. The variety of materials of the universe which result from a combination of relatively few different atoms.

3. The changes of the chemical structure of matter which involve changes in energy.

Atoms, Molecules and Elements

Measurable Objectives

1. Given the model atomic components, the pupil will be able to construct a model hydrogen and a model water molecule. He will give the reasons for the molecular arrangement. Seventy-five percent accuracy is minimal.

2. Given a small bowl of mixed water, iron filings and common table salt, a flame, and a magnet, the pupil will be able to extract accurately the ingredients from the bowl. From this exercise he will deduce whether the ingredient is a mixture or compound.

3. Given a cylinder, a plunger, and a cork, a teacher-demonstration showing air compression and the popping of the cork out of the cylinder, the pupil will describe what happens to the air molecules in the process of expansion and contraction. Ninety percent accuracy is minimal.

Never be ashamed of the strange.

Theodore Roethke

4. Given a sample of water, test tube of air, and a bar of soap, the pupil will explain accurately the relative differences in characteristics of each kind of matter. (liquid, gases, solids)

5. Given a small mirror on which the pupil has gently blown his breath, he will explain accurately how water accumulation takes places as molecules, as a gas and how it develops as a liquid in the cooling process.

6. Given a balloon full of air, the pupil will explain accurately why the balloon decreases in size as the balloon is cooled.

7. Given assorted chemicals and equipment, the pupil will set up a demonstration or experiment using proper safety precautions correctly in laboratory procedures.

8. Given a sample of water or parafin, a flame, and the use of a refrigerator, the pupil will demonstrate his understanding of "changing the state of matter." Proficiency will be correct before the pupil progresses further in his study.

Atoms, Molecules, and Elements Outline References

Books:

Blough, Glenn, Science is Discovering #5, Chicago: Scott, Foresman and Company, 1965, pp. 240--see pages 162-173.

Brandwein, Paul F. Concept in Science #5, New York: Harcourt, Brace and World Inc. 1966, pp. 376--see pages 52-60. .

Brandwein, Paul F. Concept in Science #6, New York: Harcourt, Brace and World Inc. 1966, pp. 440--see pages 289-299.

Katz, Morris, Science Through Discovery #5, New York: L. W. Singer Company, 1968, pp. 336--see pages 165-177.

Katz, Morris, Science Through Discovery #6, New York: L. W. Singer Company, 1968, pp. 336--see pages 162-173.

Novak, Joseph D. The Dynamic World of Science #6, Indianapolis: Bobbs Merrill Company, Inc. 1966, pp. 360--see pages 44-75.

*Schmidt, Victor E. and Rockcastle, Verne, Teaching Science With Everyday Things, St. Louis: McGraw-Hill Book Co. 1963, pp. 167.

Those who are willing to be vulnerable move among mysteries.

Theodore Roethke

Teacher's Publishing Corporation, Atoms and Molecules, A National Science Teachers Association Publication, Darien, Conn: The Corporation, pp. 94--see pages 31-50.

Victor, Edward, Molecules and Atoms, Chicago: Follett Publishing Company, 1963, pp. 32.

Films:

"Atomic Energy Inside the Atom: EBF, B/W, 14 min. IMC #118.

"Explaining Matter, Atoms and Molecules" EBF, Color, 14 min. IMC #248.

Tapes:

"Atoms and Molecules" Imperial Productions, Inc. 1965, IMC #T-71.

"Chemistry in Our Lives" Imperial Productions, Inc. 1965, IMC #T-80.

Compounds, Mixtures, Solutions and Their Formation

Measurable Objectives

1. Given an assortment of common elements, mixtures, and compounds, the pupil will distinguish with eighty percent accuracy into which category each belongs.

2. Given a question, "list the ten most common elements of the earth's crust," the pupil will respond with eighty percent accuracy in naming those elements and describe at least half of these elements' characteristics.

3. Place a glass of water on the demonstration table. Place a teaspoon of salt in the water. The pupil will respond correctly as to why the water does not raise in the glass.

4. Asked to define chemistry, the pupil will do so correctly.

If you think that you can say in your words what Keats said in his, then you really haven't read his poems. Literature is read if it rings inside. Even if it never appears on college boards it was worth the reading.

Dr. Lazer Goldberg

Compounds, Mixtures, Solutions and Their Formation Outline References

Books:

Blough, Glenn, *Science is Discovering #5*, Chicago: Scott, Foresman and Co. 1965, pp. 240--see pages 162-178.

Brandwein, Paul F. *Concept in Science #5*, New York: Harcourt, Brace and World Inc. 1966, pp. 376--see pages 57-59.

Brandwein, Paul F. *Concept in Science #6*, New York: Harcourt, Brace and World Inc. 1966, pp. 440--see pages 72-81.

Jacobson, Willard J. *Inquiring Into Science #3*, New York: American Book Company, 1968, pp. 125--see pages 65-95.

Jacobson, Willard J. *Probing Into Science #4*, New York: American Book Company, 1968, pp. 304--see pages 115-135.

Katz, Morris, *Science Through Discovery #6*, New York: L. W. Singer Company, 1968, pp. 336--see pages 66-79.

North Dakota Department of Public Instruction, *Elementary Science Handbook*, The Department, pp. 485--see pages 91-110.

Novak, Joseph D. *The Dynamic World of Science #6*, Indianapolis: Bobbs Merrill Company, Inc. 1966, pp. 360--see pages 76-83.

*Schmidt, Victor E. and Rockcastle, Verne, *Teaching Science With Everyday Things*, St. Louis: McGraw-Hill Book Co. 1968, pp. 167.

Tannenbaum, Harold E. *Teachers Manual for Chemical Change*. St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Complex Compounds, Mixtures and Solutions

Measurable Objectives

Not clear

1. Given a sample of water and a sample of soda pop, the child will give the difference in their molecular structure. Seventy-five percent accuracy is minimal.

Those who know they don't know can--if they try. Those who don't know they don't know--think they can. The teacher is human. His ignorance compared with that of the children is different only in degree. He respects all the children although he may like only some.

Dr. Lazer Goldberg

2. Given a lump of coal and a steel nail, the pupil will explain the likeness and differences. At least seventy-five percent proficiency is minimal.

3. Samples of salt, coal, and a peanut are put over a flame and burned. Salt and sugar are added to water. The pupil will describe which changes are physical and which are chemical changes.

Complex Compounds, Mixtures and Solutions Concept Outline References

Books:

Brandwein, Paul F. Concept in Science #5, New York: Harcourt, Brace and World, Inc. 1966, pp. 376--see pages 60-75.

Jacobson, Willard J. Inquiring Into Science #3, New York: American Book Company, 1968, pp. 125--see pages 79-112.

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pages 77-110.

Novak, Joseph D. The Dynamic World of Science #6, Indianapolis: Bobbs Merrill Company, Inc. 1966, pp. 360--see pages 97-106.

*Schmidt, Victor E. and Rockcastle, Verne, Teaching Science With Everyday Things, St. Louis: McGraw-Hill Book Co. 1968, pp. 167.

Teacher's Publishing Corporation, Atoms and Molecules, Darien, Conn: The Corporation, pp. 94--see pages 51-92.

There is an academic precept which says: Never listen to the young. The reverse should be true: Listen, I say, and listen close, for from them--if they are real and alive--may we hear, however faintly and distortedly--the true whispers from the infinite, the beckonings away from the dreadful, the gray life beating itself against the pitted concrete world.

Theodore Roethke

The brain has two hands. The hand as well as the brain is respected. What would the brain have been without the hand?

Dr. Lazer Goldberg

CHAPTER VI

ENERGY OF LIVING THINGS

Subtopics of Energy of Living Things

1. Cells Classification
2. Life Processes of Living Things
3. Energy of Plants, Animals and Protista
4. Energy of Movement
    a. electrical - nerve transmission
    b. gravitational - tropism
    c. light
    d. heat
    e. sound
5. All energy comes from the sun.

Goals

To familiarize and involve the pupils with the:

1. inter-relationship of life processes and energy transmission.

2. sources of energy.

3. concept that all energy comes from the sun, and without green plants, life would be virtually non-existent.

Cells

Measurable Objectives

Cell organization, classification, energy of living organisms, micro-organisms, plants and animals.

1. Given an example, as an elephant, the pupil will describe five different cell functions and explain why elephant cells are no larger than mice cells. Seventy-five percent accuracy is minimal performance.

> Unanimity is the vice of life. If no one complains about what is being done to the children, the teaching is not effective.
>
> Dr. Lazer Goldberg

2. Given two examples of organisms, bacteria and a Shetland pony, the pupil will explain the cell as a building block; some of which are all purpose, as in the bacteria organism, and cells in the Shetland pony that are specialized. Seventy-five percent accuracy is minimal.

Cells Outline References

Books:

Brandwein, Paul F. Concept in Science #5, New York: Harcourt, Brace and World Co. 1966, pp. 376--see pages 144-164.

Jacobson, Willard J. Inquiring Into Science #5, New York: American Book Company, 1968, pp. 352--see pages 115-117.

Katz, Morris, Science Through Discovery #4, New York: L. W. Singer Co. 1968, pp. 336--see pages 6-23.

Katz, Morris, Science Through Discovery #6, New York: L. W. Sincer Co. 1968, pp. 336--see pages 12-26.

Novak, Joseph D. The Orderly World of Science #5, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 170-175.

Novak, Joseph D. The Dynamic World of Science #6, Incianapolis: Bobbs Merrill Company, 1966, pp. 360--see pages 110-113.

Smith, Herbert A. Science #5, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 26-36.

Smith, Herbert A. Science #6, Illinois: Laidlaw Brothers, 1966, pp.288--see pages 22-28.

Tapes:

"Cells" Imperial Productions Inc. 1965, IMC #T-66.

Organization of Cells

Measurable Objectives

1. Given two terms, the pupil will explain the relationship of cells to organs and tissue. Eighty-five percent accuracy will be minimal.

2. Given a battery of questions related to cell protoplasm, the pupil will show or illustrate that the cell protoplasm releases energy and develops new living material.

3. Given a cell model, the pupil will demonstrate as accurately as possible how food gets into the cell and materials get out of the cell.

Reject nothing, but reorder all.

Theodore Roethke

4. Given two cells, a paramecium and a cell from the germs of ones mouth, the pupil will be able to state the differences. Seventy-five percent accuracy is minimal.

5. Given a sandwich and sufficient air, the pupil will trace the sandwich from the mouth to its body uses, showing how oxygen unites with the food to create energy and new protoplasm (body material). Seventy-five percent accuracy is minimal performance.

6. Given a complex organism, as for example, a mouse, the pupil will tell how specialized cells arrange themselves into tissues, organs and systems to form a complete organism.

7. Given a list of teacher-selected vocabulary words peculiar to the unit of study, the pupil will define accurately and spell correctly at least seventy-five percent of them.

Organization of Cells Outline References

Books:

Brandwein, Paul F. Concept in Science #5, New York: Harcourt, Brace and World Co. 1966, pp. 376--see pages 185-220.

Jacobson, Willard J. Inquiring Into Science #5, New York: American Book Company, 1968, pp. 352--see pages 121-130.

Katz, Morris, Science Through Discovery #4, New York: L. W. Singer Co. 1968, pp. 336--see pages 23-37.

Katz, Morris, Science Through Discovery #6, New York: L. W. Singer Co. 1968, pp. 336--see pages 82-137.

Novak, Joseph D. The Dynamic World of Science #6, Indianapolis: Bobbs Merrill Company, 1966, pp. 360--see pages 110-114.

Smith, Herbert A. Science #5, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 38-63.

Smith, Herbert A. Science #6, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 232-263.

Films:

"The Beginning of Vertebrate Life" EBF, Color, 11 min. IMC #1007.

"Your Body and Its Parts" EBF, Color, 12 min. IMC #86.

"Your Ears" EBF, B/W, 7 min. IMC #91.

There's nothing like ignorance to engender enthusiasm.

Theodore Roethke

"Your Eyes" EBF, B/W, 7 min. IMC #90.

"Your Teeth" EBF, B/W, 6 min. IMC #89.

"Your Sleep and Rest" EBF, B/W, 6 min. IMC #88.

Filmstrips:

"This is You" EBF, Color, 8 min. IMC #FS152.

"The Human Body" Part II, EBF, B/W, 8 min. IMC #FS7.

Classification

Measurable Objectives

1. Given thirty things selected by the teacher, the pupil will classify them with eighty percent accuracy in the following categories.

A. Living or Non-Living

B. If Living; Protista? Plant? or Animal?

C. If Protista (Micro-Organisms)

(1) bacteria
(2) algae
(3) slime molds
(4) ameba
(5) flagellates
(6) ciliates
(7) sporozoans

D. If Plants

(1) spore plants
(2) seed plants
  a. gymnosperm
  b. angiosperm

E. If Animal

(1) Vertebrate or Invertebrate
(2) If Vertebrate
  a. bird
  b. reptile
  c. amphibian
  d. fish
  e. mammal

> One of those bright young men who spends all his time being right: a brisk, metallic, negative intelligence.
>
> Theodore Roethke

(3) If Invertebrate
    a. sponge (porifera)
    b. hydra (coelenterata)
    c. flatworm (platyhelminthes)
    d. round worm (nematoda)
    e. segmented worm (annelida)
    f. bi-valve (mollusca)
    g. (arthropoda) insects, spider, crawfish centipede or millepedes

(A classification table may be drawn for convenience)

Classification Outline References

Books:

Blough, Glenn, Science is Experimenting #4, Chicago: Scott, Foresman Co. 1965, pp. 240--see pages 131-158.

Jacobson, Willard J. Inquiring Into Science #5, New York: American Book Co. 1968, pp. 352--see pages 21-54.

Smith, Herbert A. Science #4, Illinois: Laidlaw Company, 1966, pp. 288--see pages 22-57.

Filmstrips:

"Different Kinds of Animals" EBF, Color 6 min. IMC #FS238.

Micro-Organisms (Protista)

Measurable Objectives

1. Given the term protista (micro-organism), the pupil will name three micro-organism by their common name and show of what value these organisms provide for mankind. Ninety percent accuracy is minimal.

2. Given the term protista, the pupil will name three micro-organisms by their common names and show what harm they produce to man's life. Ninety percent accuracy is minimal.

3. Given a microscope, the pupil will locate, identify, and classify at least three different kinds of protista accurately.

4. Given the hypothesis, "microbes are deadly," the pupil will demonstrate proper laboratory sterilization and sanitation. One hundred percent accuracy is minimal.

His ideas were few and very between.

Theodore Roethke

5. Given the scientific terms peculiar to this unit, the pupil will define, spell and use in proper context these terms accurately.

Micro-Organisms Outline References

Books:

Blough, Glenn, Science is Adventuring #6, Chicago: Scott, Foresman Company, 1965, pp. 240--see pages 226-252.

Bond, Austin D. Experimenting in Science, Chicago: Lyons and Carnahan Co. 1963, pp. 287--see pages 32-48.

Bond, Austin D. Looking Ahead With Science, Chicago: Lyons and Carnahan Co. 1963, pp. 287--see pages 34-48.

Fischler, Abraham S. Science/A Modern Approach #6, New York: Holt, Rinehart and Winston Inc. 1966, pp. 408--see pages 164-257.

Frahm, Anne, The True Story of Bacteria, Chicago: Children's Press, 1963, pp. 48.

Katz, Morris, Science Through Discovery #6, New York: L. W. Singer Co. 1968, pp. 336--see pages 27-47.

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pages 217-231.

Tannenbaum, Harold E. Teachers Manual For Life Histories, St. Louis: Webster Division, McGraw-Hill Book Co. 1967, see pages 18-27.

Tannenbaum, Harold E. Teachers Manual for Molds, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Tannenbaum, Harold E. Very Tiny Living Things, St. Louis: Webster Division, McGraw-Hill Book Co. 1960,pp. 24.

Films:

"Life Story of the Paramecium" EBF, B/W, 11 min. IMC #98.

"Living Things Are Everywhere" EBF, B/W, 11 min. IMC #73.

"Living Things in a Drop of Water" EBF, B/W, 10 min. IMC #485.

They've sat on the secret of life so long, they no longer realize it's there.

Theodore Roethke

"Protection Against Disease" EBF, B/W, 8 min. IMC #481.

Plants

Measurable Objectives

1. Given three leaves, a conifer, a diocot, and a monocot, the pupil will be able to identify each and give the general characteristics of each type of plant accurately.

2. Given a green leaf, the pupil will be able to relate how all green leaves are a vital link in the life cycle of all living things. Ninety percent accuracy is minimal.

3. Given a diagram of a flower, (transparency master is located in the appendix) or a real flower, the pupil will relate accurately how reproduction takes place.

4. Given a selected plant, the pupil will relate how the life processes are performed. Seventy-five percent accuracy is minimal. (Motion, taking in minerals and water, giving off water, reproducing, changing food to energy, growth, respiration, circulation, absorption).

5. Given the term photosynthesis and the term respiration, the pupil will relate the difference.

Plant Outline References

Books:

Blough, Glenn, Science is Adventuring #6, Chicago: Scott, Foresman Co. 1965, pp. 240--see pages 38-65.

Blough, Glenn, Science is Discovering #5, Chicago: Scott, Foresman Co. 1965, pp. 288--see pages 6-41.

Bond, Austin D. Experimenting in Science, Chicago: Lyons and Carnahan Co. 1963, pp. 220--see pages 211-238.

Brandwein, Paul F. Concept in Science #5, New York: Harcourt, Brace and World Co. 1966, pp. 376--see pages 226-260.

Jacobson, Willard J. Inquiring Into Science #5, New York: American Book Co. 1968, pp. 352--see pages 159-178.

Katz, Morris, Science Through Discovery #5, New York: L. W. Singer Company, 1968, pp. 336--see pages 6-41.

It's not that many Americans can't think: they just don't want to.

Theodore Roethke

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pates 285-304.

North Dakota Department of Public Instruction, Elementary Science Source Book, Bismarck: The Department, pp. 255--see pages 167-226.

Smith, Herbert A. Science #5, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 41-62.

Smith, Herbert A. Science #6, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 54-76.

Tannenbaum, Harold E. Teachers Manual for Growing Seeds, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Tannenbaum, Harold E. Teachers Manual for Life Histories, St. Louis: Webster Division, McGraw-Hill Book Co. 1967, see pages 28-31.

Tannenbaum, Harold E. Teachers Manual for Life Processes of Plants, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Tannenbaum, Harold E. Teachers Manual for Living Things, St. Louis: Webster Division, McGraw-Hill Book Co. 1967, see pages 16-24.

Tannenbaum, Harold E. Teachers Manual for Plants and Animal Responses, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Tannenbaum, Harold E. Teachers Manual for Plants in Spring, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Tannenbaum, Harold E. We Read About Seeds, St. Louis: Webster Division, McGraw-Hill Book Co. 1960, pp. 24.

Teachers Publishing Corporation, Living Things, Darien, Conn: The Corporation, 1964.

Wood, Dorothy, Plants With Seeds, Chicago: Follett Publishing Co. 1963, pp. 29.

Films:

"Discovering the Forest" EBF, B/W, 11 min. IMC #1082.

"Flowering Plants and Their Parts" EBF, B/W, 16 min. IMC #1014.

The academic tendency to rest: that profound impulse to sit down.

Theodore Roethke

"Food From the Sun" EBF, Color, 10 min. IMC #1015.

"Green Plants and Sunlight" EBF, B/W, 11 min. IMC #1083.

"Growth of Seeds" EBF, Color, 14 min. IMC #228.

"Learning About Leaves" EBF, Color, 11 min. IMC #226.

"Learning About Seeds" EBF, Color, 11 min. IMC #227.

"Plankton, Pastures of the Ocean" EBF, B/W, 10 min. IMC #484.

"Seed Dispersal" EBF, B/W, 11 min. IMC #235.

"A Tree is a Living Thing" EBF, Color, 11 min. IMC #83.

"Trees and Their Importance" EBF, B/W, 12 min. IMC #1012.

Multi-Media Kits

"Introduction to Plants: D. G. Co. $15.00, 13 min. IMC #M-40.

Tapes:

"Exploring the World of Plants" Imperial Productions, Inc. 1965, IMC #T-70.

Animals

Measurable Objectives

1. Given the term "life cycle of animals," the pupil will relate accurately what is meant.

2. Given the term, "life begets life," the pupil will demonstrate accurately what is meant by the term.

3. Given the words "bat" and "whale" the pupil will explain accurately why both are considered mammals.

4. Given the words "fox" and "snake" and "turtle" the pupil will be able to explain why each is classified as a vertebrate.

5. Given the term "balance of nature" the pupil will explain with accuracy what is meant.

6. Given the term "warm blooded" and "cold blooded" the pupil will explain with accuracy what is meant.

It takes a lot of time to be a genius: you have to sit around so much doing nothing.

Theodore Roethke

Animals Outline References

Books:

Blough, Glenn, Science is Experimenting #4, Chicago: Scott, Foresman Co. 1965, pp. 240--see pages 32-53.

Blough, Glenn, Science is Discovering #5, Chicago: Scott, Foresman Co. 1965, pp. 288--see pages 185-212.

Brandwein, Paul F. Concept in Science #5, New York: Harcourt, Brace and World Co. 1966, pp. 376--see pages 265-270.

Bond, Austin D. Living With Science, Chicago: Lyons and Carnahan Company, 1963, pp. 287--see pages 32-97.

Bond, Austin D. Experimenting in Science, Lyons and Carnahan Company, 1963, pp. 220--see pages 232-242.

Fischler, Abraham S. Science/A Modern Approach #4, New York: Holt, Reinhart and Winston Inc. 1966, pp. 288--see pages 148-179.

Elementary Science Study, Teachers Guide for Behavior of Mealworms, St. Louis: McGraw-Hill Book Company, pp.57.

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pages 305-318.

North Dakota Department of Public Instruction, Elementary Science Source Book, Bismarck: The Department, pp. 255--see pages 1-166.

Novak, Joseph D. The Expanding World of Science #4, Indianapolis: Bobbs Merrill Co. 1966, pp. 288--see pages 161-193.

Novak, Joseph D. The Dynamic World of Science #6, Indianapolis: Bobbs Merrill Co. 1966, pp. 360--see pages 155-166.

Smith, Herbert A. Science #5, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 63-83.

Tannenbaum, Harold E. Teachers Manual for Plant and Animal Responses, St. Louis: Webster Division, McGraw-Hill Book Co. 1967, see pages 1-15.

Tannenbaum, Harold E. Teachers Manual for Life Histories, St. Louis: McGraw-Hill Book Company, 1967, see pages 1-17.

Oh the lies I have told to my own energies!

Theodore Roethke

Tannenbaum, Harold E. Teachers Manual for Living Things, St. Louis: Webster Division, McGraw-Hill Book Co. 1967, see pages 1-15.

Tannenbaum, Harold E. Teachers Manual for the Continuity of Life, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Teachers Publishers Corporation, Living Things, Darien, Conn: The Corporation, 1964, see pages 28-52.

Children's Books:

Brouillette, Jeanne S. Butterflies, Chicago: Follett Publishing Co. 1961, pp. 29.

Ditton, Wallace, Salmon, Chicago: Follett Publishing Co. 1962, pp. 29.

Gendron, Val, Whales, Chicago: Follett Publishing Co. 1965, pp. 30.

Meeks, Esther K. Mammals, Chicago: Follett Publishing Co. 1965, pp. 30.

Meeks, Esther K. Snakes, Chicago: Follett Publishing Co. 1962, pp. 29.

Pfaat, Robert E. Grasshoppers, Chicago: Follett Publishing Co. 1966, pp. 30.

Schoenknecht, Charles A. Ants, Chicago: Follett Publishing Co. 1961, pp. 29.

Schoenknecht, Charles A. Frogs and Toads, Chicago: Follett Publishing Co. 1960, pp. 29.

Wasson, Isabel B. Birds, Chicago: Follett Publishing Co. 1963, pp. 29.

Wood, Dorothy, Beavers, Chicago: Follett Publishing Co. 1961, pp. 29.

Uhl, Melvin John, About Creatures That Live Underground, Chicago: Melmont Publishers, Inc. 1965, pp. 31.

Uhl, Melvin John, About Eggs and Creatures That Hatch From Them, Chicago: Melmont Publishers, Inc. 1966, pp. 47.

The serious problems of life are never fully solved,
but some states can be resolved rhythmically.

Theodore Roethke

Films:

"Animals Growing Up" EBF, B/W, 11 min. IMC #190.

"Animals in Autumn" EBF, B/W, 11 min. IMC #189.

"Animals in Summer" EBF, Color, 11 min. IMC #192.

"Animals in Spring" EBF, Color, 11 min. IMC #191.

"Animals in Winter" EBF, B/W, 11 min. IMC #196.

"Animals of the Indian Jungle" EBF, Color, 11 min. IMC #338.

"Animal Town of the Prairie" EBF, Color, 10 min. IMC #193.

"Animals, Ways They Move" EBF, B/W, 11 min. IMC #195.

"Ants" EBF, B/W, 11 min. IMC #197.

"The Beaver" EBF, Color, 11 min. IMC #198.

"Big Land Animals of North America" EBF, B/W, 11 min. IMC #199.

"Bird Homes" EBF, Color, 11 min. IMC #200.

"Care of Pets" EBF, B/W, 13 min. IMC #201.

"The Fish in a Changing Environment" EBF, B/W, 11 min. IMC #1016.

"The Frog" EBF, Color, 11 min. IMC #204.

"Honeybee" EBF, B/W, 11 min. IMC # 206.

"The Housefly" EBF, B/W, 17 min. IMC #207.

"How Nature Protects Animals" EBF, B/W, 11 min. IMC #208.

"Insects in the Garden" EBF, Color, 11 min. IMC #80.

"Life Story of the Beetle" EBF, Color, 10 min. IMC #107.

"Life Story of the Crayfish" EBF, B/W, 11 min. IMC #103.

"Life Story of the Earthworm" EBF, B/W, 10 min. IMC #99.

"Life Story of the Grasshopper" EBF, B/W, 11 min. IMC #1081.

"Life Story of the Hummingbird" EBF, Color, 16 min. IMC #114.

"Life Story of the Moth" EBF, Color, 11 min. IMC #106.

"Life Story of the Oysters" EBF, B/W, 11 min. IMC #101.

"Life Story of the Red-Wing Blackbird" EBF, B/W, 11 min. IMC #112.

"Life Story of the Sea Star" EBF, B/W, 11 min. IMC #102.

"Life Story of the Snail" EBF, B/W, 11 min. IMC #100.

"Life Story of the Snake" EBF, B/W, 11 min. IMC #111.

"Life Story of the Toad" EBF, B/W, 10 min. IMC #110.

"Life Story of the Water Flea" EBF, B/W, 11 min. IMC #1011.

"Looking at Amphibians" EBF, B/W, 11 min. IMC #487.

"Looking at Birds" EBF, Color, 10 min. IMC #79.

"Looking at Fishes" EBF, Color, 17 min. IMC #76.

"Looking at Reptiles" EBF, Color, 11 min. IMC #78.

"Mammals Are Interesting" EBF, B/W, 16 min. IMC #212.

"Message from a Dinosaur" EBF, B/W, 11 min. IMC #486.

"Metamorphosis" EBF, B/W, 14 min. IMC #1008.

"Migration of Birds" EBF, B/W, 11 min. IMC #213.

"Monarch Butterfly Story" EBF, Color, 11 min. IMC #215.

*"What's Alive" Film Associates, Color, 11 min. IMC #1123.

Filmstrips:

"The African Lion" EBF, Color, 6 min. IMC #FS95.

"The Artic Wildnerness" EBF, Color, 6 min. IMC #FS125.

"Audubons, Birds of America" EBF, Color, 6 min. IMC #FS30.

"Insects" EBF, Color, 4 min. IMC #FS225.

"Insect Life Cycles" EBF, Color, 5 min. IMC #FS270.

"Living Things Through the Ages" EBF, Color, IMC #FS291.

"Vanishing Prairie" EBF, Color, 6 min. IMC #FS96.

"The Zoo Adventure" EBF, Color, 4 min. IMC #FS236.

"Walt Disney True Edventure" EBF, Color, 8 min. IMC #FS234.

"Plant and Animal Relationships" EBF, Color, IMC #FS276.

Multi-Media Kits:

"Birds and Their Song" Eye Gate, IMC #M-4.

Tapes:

"How Animals Fit Their Climates" Imperial Productions, Inc. 1965, IMC #T-63.

"A Close-up on Insects" Imperial Productions, Inc. 1965, IMC #T-69.

Can't we shake things up enough so a high, intense, passionate speech will be heard? When a long soliquy will be listened to without trick stage effects or Pretty Sir Somebody's posterior in velveteen pants?

Theodore Roethke

To make it so good that there will be no actors will ever act it right: but none can be so bad, in any windy barn, to foul it up entirely.

Theodore Roethke

CHAPTER VII

ENERGY OF NON-LIVING THINGS

Subtopics of Energy of Non-Living Things

1. Work
2. Electricity
3. Gravity
4. Machines
5. Light
6. Sound
7. Heat and Fire

Goals

To involve the student positively in the studies so that behavioral change takes place that is commenserate with the goals.

1. Basic laws of energy and their function
2. The vitalization of energy.
3. The interaction of matter and energy.
4. The interaction of energy to other forms.

Work

Measurable Objectives

1. Given two situations, one illustrating three boys pushing against a rock that weighs a ton, which is firmly lodged, the other of two boys carrying a 230 pound slain deer back to camp, the pupil without references will tell whether both are examples of work and why it is or is not work. Ninety percent accuracy is minimal performance.

2. Given 25 select words peculiar to this unit of study, the pupil will spell, define and use in proper context the words with ninety percent accuracy.

There are only a few bony concepts, but think of the metaphors!

Theodore Roethke

3. Given the words "energy" "force" and "inertia," the pupil will develop demonstrations to illustrate the scientific meanings of those words. His minimal "correctness" will be seventy-five percent.

Work Outline References

Books:

Blough, Glenn, *Science is Discovering #5*, Chicago: Scott, Foresman Company, 1965, pp. 288--see pages 53-88.

Brandwein, Paul F. *Concepts in Science #6*, New York: Harcourt, Brace and World, Inc. 1966, pp. 440--see pages 308-321.

Jacobson, Willard J. *Probing Into Science #4*, New York: American Book Company, 1968, pp. 304--see pages 145-179.

Katz, Morris, *Science Through Discovery #4*, New York: L. W. Singer Company, 1963, pp. 336--see pages 87-95.

Novak, Joseph D. *The Dynamic World of Science #6*, Indianapolis: Bobbs Merrill Company, 1966, pp. 360--see pages 181-184.

Children's Books:

Podendoff, Illa, *Energy*, Chicago: Children's Press, 1965, pp. 47.

Films:

"Energy and Work" EBF, B/W, 11 min. IMC #435.

"Forces" EBF, B/W, 14 min. IMC #116.

Electricity

Measurable Objectives

1. Given a flashlight battery (dry cell), some copper wire, some masking tape, a good light bulb, a horse shoe magnet, and six small nails, the pupil will develop demonstrations that illustrate 1. electrical energy, 2. magnetic energy, 3. light energy, 4. heat energy, 5. gravitational energy showing conversion of one source to another. He will explain the process orally or in written form with seventy-five percent accuracy.

Electricity Outline References

Books:

Blough, Glenn, *Science is Adventuring #6*, New York: American Book Co. 1968, pp. 352--see pages 179-240.

Blough, Glenn, Science is Discovering #5, Chicago: Scott, Foresman Company, 1965, pp. 288--see pages 76-80.

Bond, Austin D. Experimenting in Science #4, Chicago: Lyons and Carnahan Company, 1963, pp. 200--see pages 154-168.

Bond, Austin D. Looking Ahead With Science #6, Chicago: Lyons and Carnahan Company, 1963, pp. 287--see pages 154-181.

Brandwein, Paul F. Concepts in Science #6, New York: Harcourt Brace and World, Inc. 1966, pp. 440--see pages 230-279.

Fischler, Abraham S. Science/A Modern Approach #6, New York: Holt, Rinehart and Winston, Inc. 1966, pp. 408--see pages 254-319.

Jacobson, Willard J. Inquiring Into Science #5, New York: American Book Company, 1968, pp. 352--see pages 179-240.

Katz, Morris, Science Through Discovery #5, New York: L. W. Singer Company, 1968, pp. 336--see pages 164-193.

National Science Teachers Association, Energy in Waves, Darien, Conn: Teacher Publishers Corporation, 1964, see pages 52-72.

Neal, Charles D. Safe and Simple Projects With Electricity, Chicago: Childrens Press, 1965, pp. 157.

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pages 23-36 and 49-76.

Novak, Joseph D. The Dynamic World of Science #6, Indianapolis: Bobbs Merrill Company, 1966, pp. 360--see pages 190-204.

Novak, Joseph D. The Expanding World of Science #4, Indianapolis: Bobbs Merrill Company, 1966, pp. 288--see pages 203-224.

Smith, Herbert A. Science #5, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 184-203.

Tannenbaum, Harold E. Batteries, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Tannenbaum, Harold E. We Read About Electricity and How It Is Made, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Films:

"Electricity At Work" EBF, B/W, 13½ min. IMC #549.

"Electrons At Work" EBF, B/W, 14 min. IMC #120.

"Making Electricity" EBF, B/W, 11 min. IMC #259.

"Series and Parallel Circuits" EBF, B/W, 11 min. IMC #255.

"What Is Electric Current" EBF, B/W, 14 min. IMC #488.

Filmstrips:

"General Science" EBF, B/W, IMC #FS4.

"Science At Work" EBF, B/W, IMC #FS68.

Magnetism

Measurable Objectives

1. Given a comb, a needle, a clothes pin and a piece of paper, the pupil will demonstrate electrical fields with competency.

2. Given a simulated problem, "demonstrate the three fields, magnetism, electricity, and gravitational field," the pupil will show by simulated illustrations or by using realia what is meant and how they affect us. Seventy-five percent accuracy is minimal.

Magnetism Outline References

Books:

Blough, Glenn, Science is Experimenting, #4, Chicago: Scott, Foresman Co. 1965, pp. 240--see pages 83-98.

Bond, Austin D. Experimenting in Science #4, Chicago: Lyons and Carnahan Company, 1963, pp. 220--see pages 171-177.

Bond, Austin D. Looking Ahead With Science #6, Chicago: Lyons and Carnahan Company, 1963, pp. 287--see pages 175-181.

Katz, Morris, Science Through Discovery #5, New York: L. W. Singer Company, 1968, pp. 336--see pages 164-190.

National Science Teachers Association, Energy in Waves, Darien, Conn: Teachers Publishers Corporation, 1964, see pages 52-61.

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pages 37-48.

Novak, Joseph D. The Dynamic World of Science #6, Indianapolis: Bobbs Merrill Company, 1966, pp. 360--see pages 197-204.

Novak, Joseph D. *Expanding World of Science #4*, Indianapolis: Bobbs Merrill Company, 1966, pp. 288--see pages 203-211.

Tannenbaum, Harold E. *Magnets*, St. Louis: Webster Division, McGraw-Hill Book Co. 1967, Experiences in Science Series.

Films:

"How To Produce Electric Current With Magnets" EBF, B/W, 11 min. IMC #450.

"Magnetic, Electric, and Gravitational Fields" EBF, Color, 11 min. IMC #122.

"Michael Discovers the Magnet" EBF, B/W, 11 min. IMC #262.

Filmstrips:

"Magnets" Jam Handy, Color, IMC #FS311.

Gravitational Energy

Measurable Objectives

1. Given a meter stick, two short boards (two to three feet long), a roller skate, a spring scale, and a short piece of string; the pupil will demonstrate the principles of gravitational pull, incline planes and energy exertion. Fifty percent proficiency is minimal.

2. Given two pulleys, ten feet of string, a meter stick, a roller skate, and a fulcrum, the student will develop models to illustrate the use of the wheel, the lever, and machines.

3. Given Newton's 1st, 2nd, and 3rd laws, the student will set up demonstrations to verify them accurately. (See Scott Foresman A65 ed. *Basic Science Program 6*.

Gravitational Energy Concept Outline References

Books:

Fischler, Abraham S. *Science/A Modern Approach #6*, New York: Holt, Rinehart and Winston Company, 1966, pp. 408--see pages 82-170.

The wisdom the young make holy by their living; so intense, yet thin, the weedy pierce of pleasure, as a bush bends yet replies, riding the stream of air always around it.

Theodore Roethke

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pages 111-115.

Novak, Joseph D. The Expanding World of Science #4, Indianapolis: Bobbs Merrill Company, 1966, pp. 288--see pages 200-208.

Films:

"Forces of Gravity" McGraw-Hill, B/W, 10 min. IMC #765.

"Gravity: How It Affects Us" EBF, Color, 14 min. IMC #252.

"Laws of Motion" EBF, Color, 13 min. IMC #254.

"Magnetic, Electric and Gravitational Fields" EBF, Color, 11 min. IMC #122.

Machines

Measurable Objectives

1. Given a piece of stiff card board, a radial compass, ten stick pins and a pair of scissors, the pupil will illustrate simulated uses of the wheel. (Examples: gears, crank shafts, auto wheels, clutches, etc.) Seventy-five percent proficiency based on teacher evaluation is minimal.

Machines Concept Outline References

Books:

Brandwein, Paul F. Concepts in Science #6, New York: Harcourt, Brace ans World Company, 1966, pp.440--see pages 152-194.

Katz, Morris, Science Through Discovery #4, New York: L. W. Singer Company, 1968, pp. 336--see pages 99-123.

National Science Teachers Association, Motion, Darien, Conn: Teachers Publishing Corporation, 1964.

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pages 115-140.

Novak, Joseph D. The Dynamic World of Science #6, Indianapolis: Bobbs Merrill Company, 1966, pp. 360--see pages 167-225.

Novak, Joseph D. The Expanding World of Science #4, Indianapolis: Bobbs Merrill Company, 1966,pp. 388--see pages 241-271.

Smith, Herbert A. Science #4, Illinois: Laidlaw Company, 1966, pp. 288--see pages 184-196.

Children's Books:

Carter, Katharine, Ships and Seaports, Chicago: Children's Publishing Corporation, 1963, pp. 47.

Russell, Solreig Paulson, How Shall We Ride, Chicago: Melmont Publishers Inc. 1966.

Victor, Edward, Friction, Chicago: Follett Book Company, 1961, pp. 28.

Victor, Edward, Machines, Chicago: Follett Book Company, 1962, pp. 29.

Films:

"Energy and Work" EBF, B/W, 11 min. IMC #435.

"Making Work Easier" EBF, B/W, 10 min. IMC #261.

"The Simple Machine" EBF, B/W, 11 min. IMC #420.

"We Use Power" Churchill, Color, 11 min. IMC #790.

"What is Uniform Motion" EBF, B/W, 14 min. IMC #489.

Filmstrips:

"General Science" EBF, Color, IMC #FS4.

Multi-Media Kits:

"The Work of Simple Machines" D.G.C. IMC #M-41.

Tapes:

"Machines, the Energy Savers" Imperial Productions Inc. 1965, IMC #T-75.

"The Wheels of Modern Man" Imperial Productions Inc. 1965, IMC #T-64.

Light

Measurable Objectives

1. Given a glass of water, a lead pencil, a candle, three matches, a piece of smooth card board and a mirror, the pupil will set up demonstrations to show radiation of light from a luminous object (a lighted candle); (refraction).

2. Given two lens, a piece of toy clay for mounting, and a mirror, the pupil will demonstrate focal planes and reflection. Seventy-five percent proficiency is acceptable.

Light Concept Outline References

Books:

Blough, Glenn, Science is Adventuring #6, Chicago: Scott, Foresman Company, 1965, pp. 240--see pages 134-165.

Bond, Austin D. Experimenting In Science #4, Chicago: Lyons and Carnahan Company, 1963, pp. 220--see pages 116-136.

Bond, Austin D. Living With Science #5, Chicago: Lyons and Carnahan Company, 1963, pp. 287--see pages 134-140.

Bond, Austin D. Looking Ahead With Science #6, Chicago: Lyons and Carnahan Company, 1963, pp. 287--see pages 120-129.

Fischler, Abraham S. Science, A Modern Approach #6, New York: Holt, Rinehart and Winston, Inc. 1966, pp. 408--see pages 300-368.

Katz, Morris, Science Through Discovery #5, New York: L. W. Singer Company, 1968, pp. 336--see pages 112-137.

National Science Teachers Association, Energy in Waves, Darien, Conn: Teachers Publishing Corporation, A National Science Teachers Association Publication, 1964, see pages 72-96.

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pages 201-216.

Novak, Joseph D. The Orderly World of Science, Indianapolis: Bobbs Merrill Company, 1966, pp. 288--see pages 80-168.

Smith, Herbert A. Science #5, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 204-210.

Tannenbaum, Harold E. Color, St. Louis: Webster Division of McGraw-Hill Book Co. 1967, Experiences in Science Series.

Tannenbaum, Harold E. Light, St. Louis: Webster Division of McGraw-Hill Book Co. 1967, Experiences in Science Series.

Tannenbaum, Harold E. Light and Shadows, St. Louis: Webster Division of McGraw-Hill Book Co. 1967, Experiences in Science Series.

Films:

"How to Bend Light" EBF,Color, 11 min. IMC #491.

"Light and Color" EBF, Color, 14 min. IMC #580.

"Science of Light" Churchill Films, Color, 11 min. IMC #786.

Tapes:

"The Hidden Side of Light" Imperial Productions, Inc. 1965, IMC #T-78.

Sound

Measurable Objectives

1. Given a $\frac{1}{4}$ inch rope one hundred feet long, the pupil will demonstrate what wave length, velocity, and speed is. Ninety percent accuracy is minimal.

2. Given a metal "slinky" the pupil will demonstrate how waves travel.

3. Given an aquarium full of water, a cork floating in it, the pupil will drop a pebble in the water to demonstrate that the energy of the wave moves but the water moves very little. Explain.

4. Given a ruler, a rubber band, a tuning fork, an aquarium, and a length of wire, the student will set up demonstrations to illustrate that sound is a back and forth motion (vibrations). He will demonstrate sound waves in liquids, solids, and gases. Explanation will be orally or written. Ninety percent accuracy is minimal.

Sound Concept Outline References

Books:

Blough, Glenn, Science is Discovering #5, Chicago: Scott, Foresman Company, 1965, pp. 288--see pages 213-246.

Bond, Austin D. Experimenting In Science #4, Chicago: Lyons and Carnahan Company, 1963, pp. 220--see pages 137-147.

Bond, Austin D. Living With Science #5, Chicago: Lyons and Carnahan Company, 1963, pp. 287--see pages 126-134.

Bond, Austin D. Looking Ahead With Science #6, Chicago: Lyons and Carnahan Company, 1963, pp. 287--see pages 131-146.

Fischler, Abraham S. Science, A Modern Approach #6, New York: Holt, Rinehart and Winston Inc. 1966, pp. 408--see pages 258-300.

MacCracken, Helen Colmon, Science Through Discovery #5, New York: L. W. Singer Company Inc. 1968, pp. 288--see pages 42-75.

National Science Teachers Association, Energy in Waves, Darien, Conn; Teachers Publishing Corporation, 1964, see pages 23-51.

Novak, Joseph D. The Expanding World of Science #4, Indianapolis: Bobbs Merrill Company, 1966, pp. 288--see pages 249-255.

Smith, Herbert A. Science #5, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 214-226.

Tannenbaum, Harold E. Sound, St. Louis: Webster Division of McGraw-Hill Book Co. 1967, Experiences in Science Series.

Children's Books:

Neal, Charles D. Sound, Chicago: Follett Book Company, 1962, pp. 29.

Films:

"Learning About Sound" EBF, B/W, 8 min. IMC #256.

"Sound and How It Travels" EBF, B/W, 11 min. IMC #421.

"Vibrations" EBF, B/W, 14 min. IMC #490.

"Waves and Energy" EBF, B/W, 11 min. IMC #422.

Filmstrips:

"Science at Work" EBF, Color, IMC #FS68.

Tapes:

"The Invisible Wonder" Imperial Productions Inc. 1965, IMC #T-77.

Heat and Fire

Measurable Objectives

1. Given a balloon, a wide mouth Pyrex jar, and a flame of heat, the pupil will demonstrate what happens to air when it is heated. (Place balloon over the jar, heat the bottom.) He will explain with ninety percent accuracy what happens to the composition of the air, why it expands and contracts.

2. Given a piece of wire, the student will heat the end to demonstrate conductivity. He will demonstrate heat conductivity with other materials and explain the differences.

3. Given a variety of inflamable materials, the pupil will demonstrate kindling temperature.

4. Given oily rags, dry rags, two coffee cans and two thermometers, the student will demonstrate the heat effect of dry rags in a can and oily rags in a can by placing a thermometer in each. He will then explain spontaneous combustion and kindling points.

Heat and Fire Concept Outline References

Blough, Glenn, Science is Discovering #5, Chicago: Scott, Foresman Company, 1965, pp. 288--see pages 253-267.

Blough, Glenn, Science is Experimenting #4, Chicago: Scott, Foresman Company, 1965, pp. 240--see pages 163-192.

Bond, Austin D. Experimenting In Science, Chicago: Lyons and Carnahan Company, 1963, pp. 220--see pages 147-157.

Bond, Austin D. Living With Science, Chicago: Lyons and Carnahan Company, 1963, pp. 287--see pages 140-153.

Katz, Morris, Science Through Discovery #4, New York: L. W. Singer Company, 1968, pp. 336--see pages 160-199.

National Science Teachers Association, Energy in Waves, Darien, Conn: Teachers Publishing Corporation, 1964, see pages 72-96.

North Dakota Department of Public Instruction, Elementary Science Handbook, The Department, pp. 485--see pages 169-183.

Novak, Joseph D. The Dynamic World of Science, Indianapolis: Bobbs Merrill Company, 1966, pp. 360--see pages 185-205.

Novak, Joseph D. The Expanding World of Science, Indianapolis: Bobbs Merrill Company, 1966, pp. 288--see pages 255-271.

Films:

"Heat and How We Use It" EBF, B/W, 11 min. IMC #253.

"Fire; What Makes It Burn" EBF, B/W, 11 min. IMC #250.

We're not going to split the heart of reality: not until the third semester.

Theodore Roethke

CHAPTER VIII

SPACE

Subtopics of Space

1. Galaxies
2. Man in space
3. Space,force, and energy
4. Achievements in space
5. Manned space flight
6. The future of space

Goals

Awareness of:

1. the composition of space and the methods of space study.
2. the earth's position in the solar system.
3. the patterns, positions, and movements of celestial bodies.
4. the problem of space travel and how man can adapt to these changes.

Galaxies

Man and His Achievements in Space

The Future in Space

Measurable Objectives

1. Given ten school children and a space on the play ground, the pupil can arrange the "planets" around a "sun" in our solar system. Distant approximation in the placing of the planets will be near correct.

or (see 2)

2. Given toy clay and a large sheet of paper, the pupil can make a model solar system on the sheet of paper. Approximate distant calculations and size scaling of the planets are expected to be relatively accurate. The child will be able to tell or write why there is a difference in length of time that each of the planets revolve around the sun and discuss rotation times.

3. Given thirty words peculiar to this unit of study, the child will be able to define, spell, and use them in proper context. Ninety percent accuracy is minimal.

4. Given a magnet, two books and a steel ball, (ball bearing) the pupil will illustrate how forces are drawn to one another.

5. Given the light years distance to Mars from the earth, the pupil will be able to calculate how old he would be when he reached Mars if he left earth by rocket and traveled at a rate of 20,000 miles an hour.

6. Given a tennis ball, a knitting needle, a flashlight, a protractor, a ruler, and a pencil, the pupil will be able to set up a demonstration to show earth rotation, night and day, polar tilt, degrees in meridians, pointing out the prime meridian, set up the time zones with reasonable accuracy.

7. Given the term "a.m." and "p.m.", the pupil will be able to demonstrate what is meant--(ante meridiem, post meridiem).

8. Given the fact that our earth travels in orbit at a rate of about 66,000 miles an hour, the pupil should be able to calculate how far he has traveled in twenty-four hours though he had hardly moved, relatively speaking. Consideration should be ascertained as to the fact that the earth also rotates at a rate of just about 1070 miles an hour.

9. Given a rubber ball to represent the earth, with a rubber band attached, the pupil will demonstrate how the speed of the outward thrust of the ball is countered by the gravitational pull to hold the ball in orbit as it is swung about his head. The pupil should be able to demonstrate what happens when the speed of the ball is accelerated.

10. Given a tennis ball, a knitting needle, and a flashlight, the pupil can demonstrate the earth's tilt and how the sun's rays strike directly on areas of the earth at some periods of the year and how it strikes the same area at a slant at other times. He will be able to explain why there is less heat concentration when the light is slanted.

11. Given a basket ball representing the earth, and a card saying, "moon," the pupil will revolve around the ball making one complete rotation as he has made one revolution around the ball. He will demonstrate why only one side of the moon is visible to us on earth of the real moon.

12. Given a large ball to represent the sun, a smaller ball to represent the earth and a small ball to represent the moon, the pupil will demonstrate what the proximity one is to another, how the eclipses occur, and how the moon looks crescent, quarter, half and full moon at night. He will do this with ninety percent accuracy.

13. Taken out-doors on a clear night, the pupil will be able to recognize the big dipper constellation and point to Polaris (North Star).

14. Given a drawing of the cross-section contour of an airplane wing, the pupil will illustrate how air pressure gives lift to an airplane's wing as it travels through air.

15. Given a toy rubber balloon, the pupil will demonstrate the principle of jet propulsion.

16. Given a simulated trip to the moon, the pupil will list and explain at least four major problems of consideration he might be confronted with in making such a trip.

17. Given a choice of topics, Sputnik, Appollo, Telstar, or Mariner, the pupil will give a narrative of the projects.

18. Given a choice of one of three space projects; one of communications as Telstar, one of research as Project Explorer, Vanguard, Tiros, or Nimbus; or space exploration as Project Mariner or Surveyor, the pupil will project future explorations. Teacher evaluation criteria will prevail.

Space Concept Outline References

1. Galaxies

Books:

Blough, Glenn, Science is Discovering #5, Chicago: Scott, Foresman Company, 1965, pp. 288--see pages 113-148.

Bond, Austin D. Experimenting in Science #4, Chicago: Lyons and Carnahan Company, 1963, pp. 220--see pages 88-108.

Bond, Austin D. Living With Science #5, Chicago: Lyons and Carnahan Company, 1963, pp. 287--see pages 94-119.

Bond, Austin D. Looking Ahead With Science #6, Chicago: Lyons and Carnahan Company, 1963, pp. 287--see pages 94-119.

Children's Books:

Tannenbaum, Harold E. Let's Read About the Stars, St. Louis: Webster Division, McGraw-Hill Book Co. 1967.

Why should discussions disappear, the edge of thought
slide so far away, the shade of what we said be less,
be less. . . .. Thought changes into the shade of light.

Theodore Roethke

Tellander, Marian, Space, Chicago: Follett Book Company, 1960, pp. 29.

Films:

"Planets in Orbit" EBF, B/W, 10 min. IMC #416.

"What is Space" EBF, B/W, 11 min. IMC #443.

Filmstrips:

"Astronomy" D.G.C. Color, IMC #FS299.

"Earth and its Neighbors in Space" EBF, Color, IMC #FS298.

"Earth and the Universe Series" SVE, B/W, IMC #FS310.

"Scanning the Universe" EBF, Color, IMC #FS224.

Tapes:

"Our Nearest Star, the Sun" Imperial Productions Inc. 1965, IMC #T-79.

"Our Satellite the Moon" Imperial Productions Inc. 1965, IMC #T-68.

"Taking A Closer Look At The Stars" Imperial Productions Inc. 1965, IMC #T-76.

"A Trip to the Planets" Imperial Productions Inc. 1965, IMC #T-61.

2. Man and His Achievements in Space

Books:

Blough, Glenn, Science is Adventuring #6, Chicago: Scott, Foresman Company, 1965, pp. 240--see pages 166-192.

Bond, Austin D. Looking Ahead With Science #6, Chicago: Lyons and Carnahan Company, 1963, pp. 287--see pages 201-207.

Jacobson, Willard J. Inquiring into Science #5, New York: American Book Company, 1968, pp. 352--see pages 241-268.

National Science Teachers Association, Space, Darien, Conn: Teachers Publishing Corporation, 1964.

Novak, Joseph D. The Dynamic World of Science #6, Indianapolis: Bobbs Merrill Company, 1966, pp. 360--see pages 289-303.

He teaches a class like an animal trainer.

Theodore Roethke

Smith, Herbert A. *Science #5*, Illinois: Laidlaw Brothers, 1966, pp. 360--see pages 136-146.

Smith, Herbert A. *Science #6*, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 138-155.

Children's Books:

Victor, Edward, *Planes and Rockets*, Chicago: Follett Book Company, 1965, pp. 30.

3. The Future of Space

Books:

Blough, Glenn O. *Science is Adventuring #6*, Chicago: Scott, Foresman Company, 1965, pp. 240--see pages 184-194.

Blough, Glenn O. *Science is Experimenting #4*, Chicago: Scott, Foresman Company, 1965, pp. 240--see pages 214-229.

Jacobson, Willard J. *Probing into Science #4*, New York: American Book Company, 1968, pp. 304--see pages 241-280.

Novak, Joseph D. *The Dynamic World of Science #6*, Indianapolis: Bobbs Merrill Company, 1966, pp. 360--see pages 315-342.

Smith, Herbert A. *Science #5*, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 165-183.

Smith, Herbert A. *Science #6*, Illinois: Laidlaw Brothers, 1966, pp. 288--see pages 156-171.

NASA Publications: Available at the Instructional Media Center Professional Library.

NASA, *Activities in Science Related to Space*, Washington, D. C: U. S. Government Printing Office, 1966 (#0-219-228) pp. 54, IMC Professional Library Call Number 1216.5.

NASA, *Aerospace Bibliography* 3rd Ed. Washington, D. C: U. S. Government Printing Office, 1966 (#0-795-278) pp. 71, $.50, IMC Professional Library Call Number 1216.5.

NASA, *Communications Satellites*, Washington, D. C: U. S. Government Printing Office, 1966 (#0-222-719) pp. 16, IMC Professional Library Call Number 1216.5.

NASA, *Experiences in Space Science*, Washington, D.C: U. S. Government Printing Office, 1967 (#0-268-994) pp. 88, IMC Professional Library Call Number 1216.5.

NASA, *From Here, Where?* Washington, D. C: U. S. Government Printing Office, 1965, pp. 192, $1.25, IMC Professional Library Call Number 1216.5.

NASA, *A Guide to Careers in Aero-Space Technology*, Washington, D. C: U. S. Government Printing Office, 1966 (#0-223-846) pp. 49, IMC Professional Library Call Number 1216.5.

NASA, *Introducing Children to Space-The Lincoln Plan*, Washington D. C: U. S. Government Printing Office,1966 (#0-212-353) pp. 159, $1.25, IMC Professional Library Call No. 1216.5.

NASA, *Learning About Space Careers*, Washington, D. C: U. S. Government Printing Office, 1966 (#OF-210-925) pp. 23, $.25, Imc Professional Library Call Number 1216.5.

NASA, *NASA Facts Alouette-Canada's First Satellite*, Washington, D. C: U. S. Government Printing Office, 1964, (#OF-742-579) pp. 6, $.15, IMC Professional Library Call Number 1216.5.

NASA, *NASA Facts Biosatellites*, Washington, D. C: U. S. Government Printing Office, 1965, (#OF-764-292) pp. 8, $.15, IMC Professional Library Call Number 1216.5.

NASA, *NASA Facts The Countdown*, Washington, D. C: U. S. Government Printing Office, 1967, (#0-269-949) pp. 4, $.05, IMC Professional Library Call Number 1216.5.

NASA, *NASA Facts Explorer XXIX (The Geodetic Explorer)*, Washington, D. C: U. S. Government Printing Office, 1966 (#0-214-500) pp. 8, $.10, IMC Professional Library Call Number 1216.5.

NASA, *NASA Facts Gemini Pictorial*, Washington, D. C: U. S. Government Printing Office, 1966, $.20, IMC Professional Library Call Number 1216.5.

NASA, *NASA Facts The Laser*, Washington, D. C: U. S. Government Printing Office, 1966, (#OF-219-661) pp. 8, $.10, IMC Professional Library Call Number 1216.5.

NASA, *NASA Facts Lifting Bodies*, Washington, D. C: Government Printing Office, 1967 (#OF-242-102) pp. 8, $.10, IMC Professional Library Call Number 1216.5.

NASA, *NASA Facts Living in Space*, Washington, D. C: Government Printing Office, 1966 (#OF-218-584) pp. 12, $.15, IMC Professional Library Call Number.1216.5.

NASA, *NASA Facts Manned Space Flight: Apollo*, Washington, D. C: U. S. Government Printing Office, 1967, (#0-249-471) pp. 16, $.15, IMC Professional Library Call Number 1216.5.

NASA, *NASA Facts Manned Space Flight: Projects Mercury and Gemini*, Washington, D. C: U. S. Government Printing Office, 1967 (#0-212-017) pp. 12, $.15, IMC Professional Library Call Number.1216.5.

NASA, NASA Facts Orbiting Solar Observatory, Washington, D. C: U. S. Government Printing Office,1966 (#OF-224-252) pp. 8, $.10, IMC Professional Library Call Number 1216.5.

NASA, NASA Facts The Pioneer Spacecraft, Washington, D. C. U. S. Government Printing Office, 1967 (#0-269-603) pp. 3, $.10, IMC Professional Library Call Number 1216.5.

NASA, NASA Facts A Report from Mariner IV, Washington, D. C: U. S. Government Printing Office, 1966, (#OF-214-293) pp. 8, $.10, IMC Professional Library Call Number 1216.5.

NASA, NASA Facts Saturn V, Manned Flight to the Moon, Washington, D. C: U. S. Government Printing Office, 1967 (#0-249-077) $.25, IMC Professional Library Call Number 1216.5.

NASA, NASA Facts Simulators, Washington, D. C: U. S. Government Printing Office, 1967 (#0-269-559) pp. 8, $.10, IMC Professional Library Call Number 1216.5.

NASA, NASA Facts Spacecraft Tracking and Communication, Washington, D. C: U. S. Government Printing Office, 1967 (#0-269-946) pp. 4, $.05, IMC Professional Library Call Number 1216.5.

NASA, NASA Facts Suggestions for Lesson Planning for Manned Space Flight: Projects Mercury, Gemini, and Apollo, Washington, D. C: U. S. Government Printing Office, 1966 (#OF-797-463) pp. 11, IMC Professional Library Call Number 1216.5.

NASA, NASA Facts Surveyor, Washington, D. C: U. S. Government Printing Office, 1967 (#0-269-560) pp. 12, $.15, IMC Professional Library Call Number 1216.5.

NASA, NASA Facts Telemetry, Washington, D. C: U. S. Government Printing Office, 1967 (#0-270-778) pp. 4, $.05, IMC Professionaly Library Call Number 1216.5.

NASA, NASA Facts United States Launch Vehicles for Peaceful Exploration of Space, Washington, D. C: U. S. Government Printing Office, 1967 (#OF-242-085) $.25, IMC Professional Library Call Number 1216.5.

NASA, NASA Facts V/STOL Aircraft, Washington, D. C: U. S. Government Printing Office, 1966, (#OF-798-972) pp. 8, $.15, IMC Professional Library Call Number 1216.5.

NASA, NASA Facts Weightlessness, Washington, D. C: U. S. Government Printing Office, 1967, (#0-270-779) pp. 4, $.05, IMC Professional Library Call Number 1216.5.

The cage is open; you may go.

Theodore Roethke

NASA, *NASA's Space Science and Applications Program*, Washington, D. C: U. S. Government Printing Office, 1967, pp. 567, IMC Professional Library Call Number 1216.5.

NASA, *Model Spacecraft Construction*, Washington, D. C: U. S. Government Printing Office, 1966 (#0-229-357) pp. 184, $1.00, IMC Professional Library Call Number 1216.5.

NASA, *The Planetarium*, Washington, D. C. U. S. Government Printing Office, 1966 (#0223-572) pp. 52, IMC Professional Library Call Number 1216.5.

NASA, *Project Gemini*, Washington, D. C: U. S. Government Printing Office, 1966 (#0-223-959) pp. 52, $.45, IMC Professional Library Call Number 1216.5.

NASA, *Report from Mars Mariner IV 1964-1965*, Washington, D. C: U. S. Government Printing Office, 1966 (#0-208-575) pp. 45, $.50, IMC Professional Library Call Number 1216.5.

NASA, *Seven Steps to a Career in Space Science*, Washington, D. C: U. S. Government Printing Office, 1966 (#0F-210-926) pp. 62, $.45, IMC Professional Library Call Number 1216.5.

NASA, *The Shapes of Tomorrow*, Washington, D. C: U. S. Government Printing Office, pp. 201, $1.50, IMC Professional Library Call Number 1216.5.

NASA, *Short Glossary of Spcae Terms* 2nd Ed. Washington, D. C: U. S. Government Printing Office, 1966 (#66-6008) pp. 51, $.25, IMC Professional Library Call Number 1216.5.

NASA, *Space Jobs*, Washington, D. C: U. S. Government Printing Office, 1967 (#0F-258-873) pp. 10, $.15, IMC Professional Library Call Number 1216.5.

NASA, *Space: The New Frontier*, Washington, D. C: U. S. Government Printing Office, 1967 (#0-223-626) pp. 95. $.75, IMC Professional Library Call Number 1216.5.

NASA, *Surveyor I A Preliminary Report*, Springfield, Virginia: Clearinghouse for Federal Scientific and Technical Information, 1966, pp. 39, $.75, IMC Professional Library Call Number 1216.5.

NASA, *Tracking*, Washington, D. C: U. S. Government Printing Office, 1966 (#0-799-959) pp. 22, $.15, IMC Professional Library Call Number 1216.5.

NASA, *What's Up There?* Teachers Ed. Washington, D. C: U. S. Government Printing Office, 1964 (#720-355-64 teacher) pp. 144, $1.00, IMC Professional Library Call Number 1216.5.

APPENDIX

APPENDIX

FIELD TRIPS

CONDUCTING A FIELD TRIP

General

Field trips are indispensable in developing the concepts of science. Illustrations of these concepts can be felt, smelled, touched, listened to and thoroughly viewed in their natural environment. Most of these things can be found within a several-minute walk of the school building.

Preparation For The Trip

Prior to the trip, the teacher should determine specifically what the purpose for the trip will be. The great outdoors is a complete laboratory with a variety of almost everything. If the children are not guided specifically, they will see so much they will literally see nothing. Models must be drawn from and studied in depth if much worth is to be received. Comparisons and contrasts can easily be seen in living and physical science. The pupils may take sketches in spiral notebooks of the phenomena that is being studied. Cameras can be used to record the phenomena too.

Preliminary Instructions

Purpose of trip and destination
Time of departure and return
Appropriate clothing (jackets, rubbers, etc.)
Some specific things to observe, collect or discover
Equipment needed, if any (magnifying glasses, containers, notebooks)
Safety precautions
Necessity of keeping together and with the leader

Conducting The Trip

Be sure that all comments on observations are simple and adapted to the level of the group.

Encourage questions and be sure that all hear and understand the questions and answers.

Repeat all important points.

Give more than facts and names; if possible, present "human interest" information about items seen.

Make the most of unexpected occurrences and observations volunteered by the group.

Emphasize the relationship or principles of ecology to conservation, to life processes, foods, and classifications when possible.

Summary Of The Trip

Discuss the highlights and important findings. This is properly done on the spot after observations have been made and relationships pointed out.

When the ground is dry, pupils can be seated comfortably in a circle. If a particular area of the school grounds is frequently used for field trips, it may be possible to provide several logs to sit on or picnic table benches for the summarizing session.

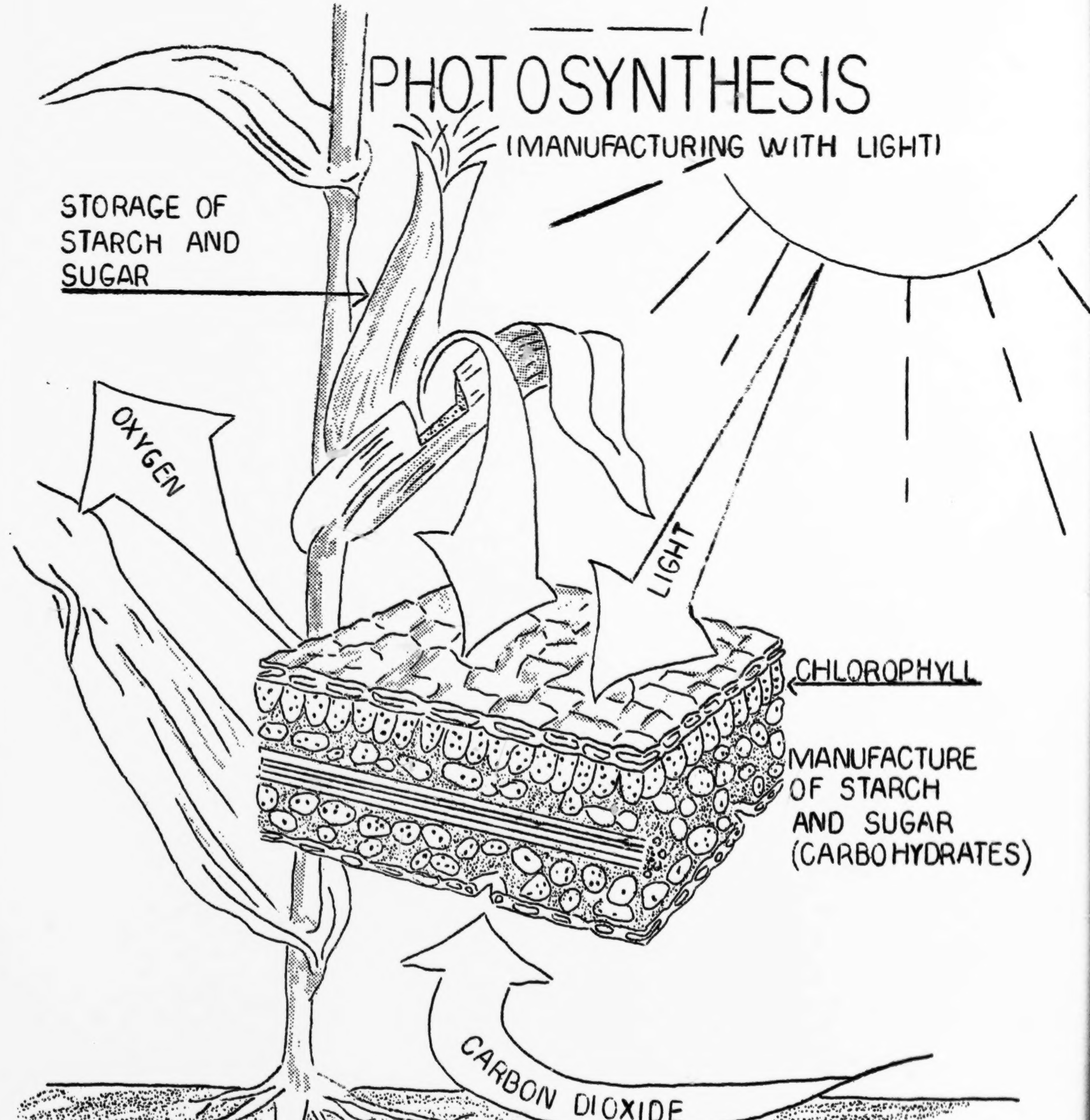
If necessary, the summary can be made in the classroom immediately on returning. The important thing is that the trip should be so timed as to provide opportunity for a summary.

The field trip should be cleared through the proper administrative channels. A wise teacher will send a copy of her "trip purpose" or "trip objectives" to the principal prior to each trip. Planned experiences as field trips should be part of the teacher's lesson plans.

See Turtox Service Leaflets No. 1 listed in the teachers references for further details.

PHOTOSYNTHESIS

(MANUFACTURING WITH LIGHT)


STORAGE OF STARCH AND SUGAR
OXYGEN
LIGHT
CHLOROPHYLL
MANUFACTURE OF STARCH AND SUGAR (CARBOHYDRATES)
CARBON DIOXIDE
WATER + FOOD

TRANSPARENCY MASTER

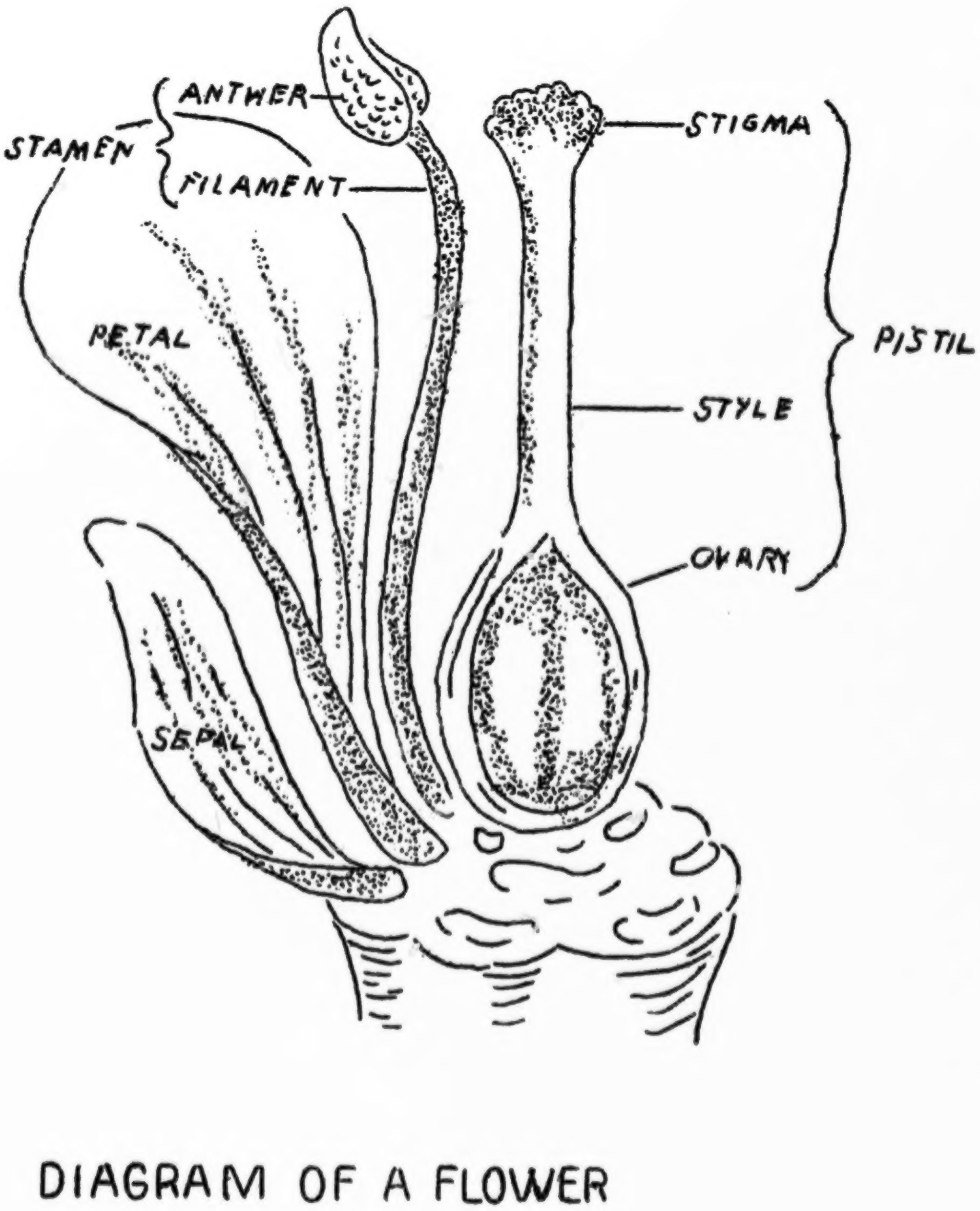
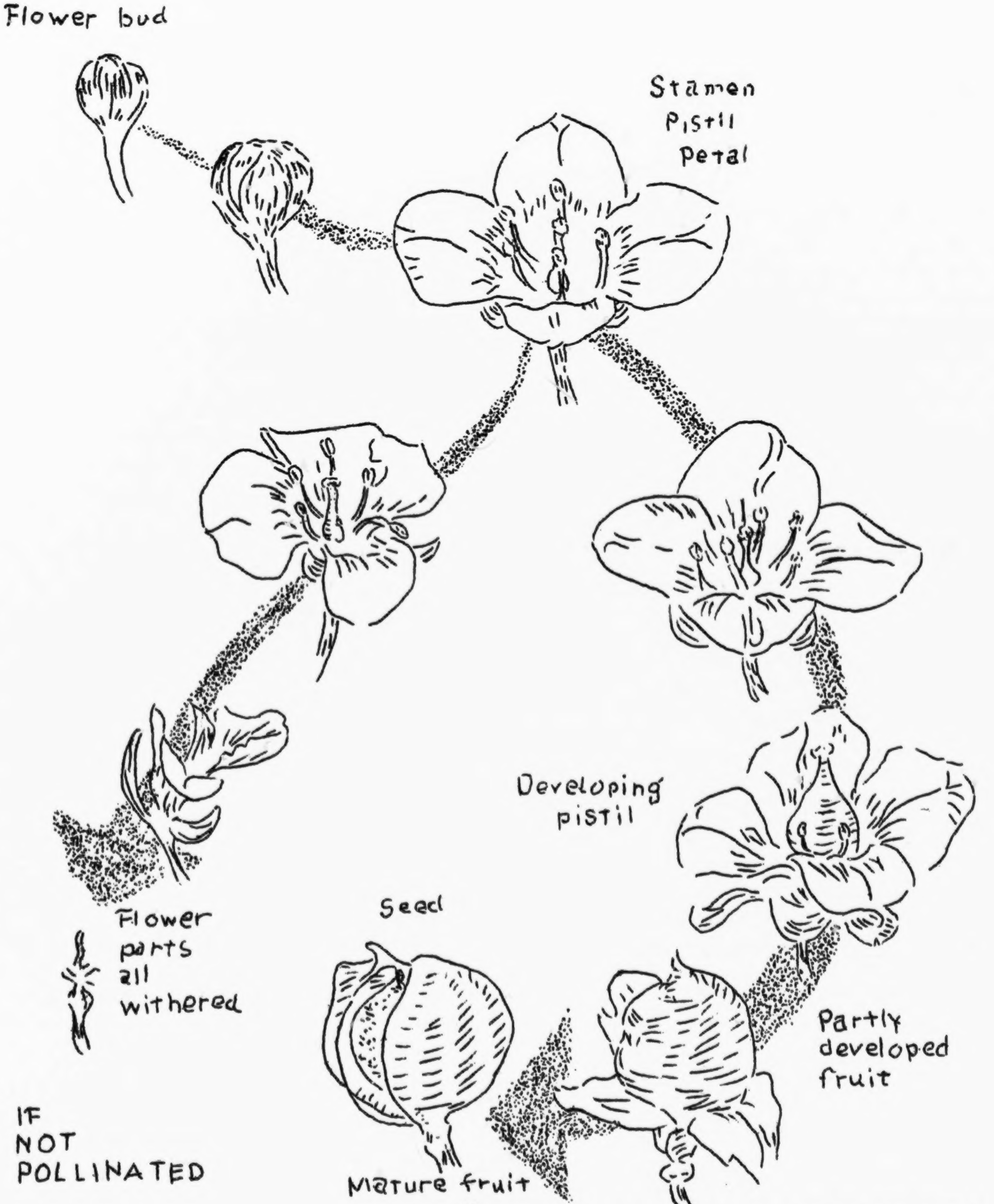

ANTHER
STAMEN
FILAMENT
PETAL
SEPAL
STIGMA
STYLE
OVARY
PISTIL

DIAGRAM OF A FLOWER

REPRODUCTION IN FLOWERING PLANTS


Flower bud
Stamen
Pistil
Petal
Developing pistil
Flower parts all withered
Seed
Partly developed fruit
IF NOT POLLINATED
Mature fruit
IF POLLINATED

ADDRESSES

Listing of Nation-Wide Elementary Science Programs

AAAS, Commission on Science Education, Science, A Process Approach, Director, John R. Mayor, 1515 Massachusetts Avenue, Northwest, Washington, D. C. - Telephone 202-387-7171 - Materials are published by Zerox Corporation, Richard Christy area representative, Box 674, Bismarck, North Dakota 58501.

Elementary Science Study, 55 Chapel Street, Newton, Massachusetts 02160, published by McGraw-Hill Book Co. Manchester Road, Manchester, Missouri 63011 - Area representative for McGraw-Hill Book Co. Willard Biederstedt, 505 North High, Aberdeen, South Dakota 57401.

~~Oregon Museum of Science and Industry (OMSI) 10187 Southwest Wilshire, Portland, Oregon 97225. Area Code 503/292-0300.~~

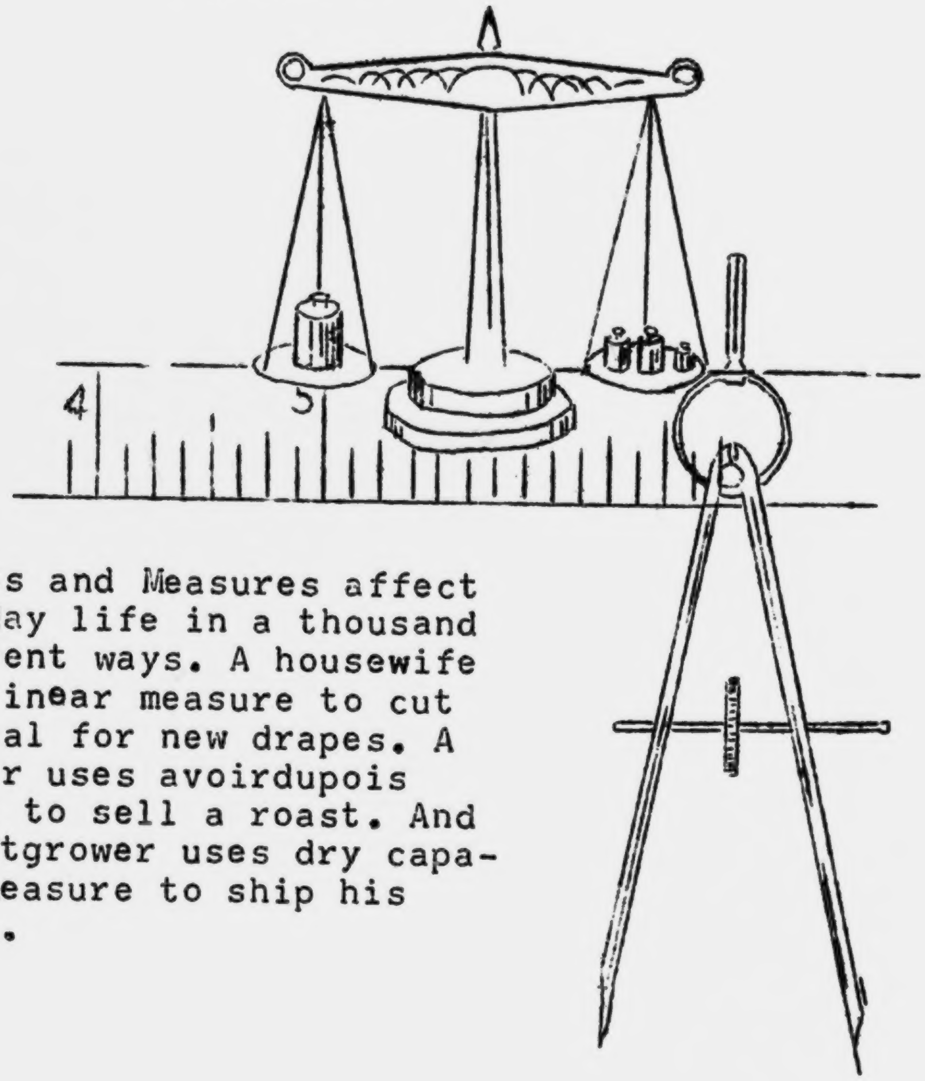
Science Curriculum Improvement Studies, Department of Physics, University of California, Berkeley, California 94720 - published by D. C. Heath and Co. - Area representative William J. Elliott, Route 1, Frederick, South Dakota 57441.

Principal Elementary Science Curriculum Studies

	Grades												
	K	1	2	3	4	5	6	7	8	9	10	11	12
SCIENCE				Secondary School Science Project (Princeton)							←(c-A)→		
				Earth Science Curriculum Project (AGI)						←(c-A)→			
				Introductory Physical Science Project (ESI)						←(c-A)→			
				Elementary School Science Project (U. of Illinois)		←———	———	—(c-E)—	———	———→			
	←———	(c-A)	———→	←———	—(b-A)—	———	—→						
					Science Curriculum Improvement Study (U.Calif.)								
	←———	———	(b, c-E	———	———	———	———→						
				Elementary School Science Project (U. Calif.)									
	←———	———	(b, c-E	———	———	———	———	———	———→				
				Elementary Science Study (ESI)									
	←———	———	(c-A)	———	———	———	———→						
				Commission on Science Education (AAAS)									
	←———	———	(b-E)	———	———	———	———	———	———	———→			
				School	Science	Curriculum Project (U. Illinois)							

KEY TO SYMBOLS:

a.	Planned or projected	CEE	Commission on Engineering Education
b.	Preliminary version	ESI	Educational Services Incorporated
c.	Extended trial version	AAG	American Association of Geographers
d.	Released for general use	AAA	American Anthropological Association
A.	Text and Supplementary Materials	ASA	American Sociological Association
B.	Teacher Training Films and Course Materials	AGI	American Geological Institute
C.	Guidelines for Curriculum & Course Development	AAAS	American Association for the Advancement of Science
D.	Research in Learning		
E.	Unsequenced Units and Source Materials		



Weights and Measures affect everyday life in a thousand different ways. A housewife uses linear measure to cut material for new drapes. A butcher uses avoirdupois weight to sell a roast. And a fruitgrower uses dry capacity measure to ship his apples.

Linear Measure--Metric System

		(United States)
	1 angstrom(A.)	= 0.000000004in.
10A.	=1 millimicron(mμ.)	= 0.00000003937in.
1,000mμ.	=1 micron(μ.)	= 0.00003937in.
1,000μ.	=1 millimeter(mm.)	= 0.03937in.
10mm.	=1 centimeter(cm.)	= 0.3937in.
10cm.	=1 decimeter(dm.)	= 3.937in.
10dm.	=1 meter(m.)	= 39.37in.
10m.	=1 decameter(dkm.)	=393.7in.
10dkm.	=1 hectometer(hm.)	=328.0833ft.
10hm.	=1 kilometer(km.)	= 0.62137mi.
10km.	=1 myriameter (mym.)	= 6.2137mi.

Linear Measure--United States

		(Metric)
	1 inch (in.)	= 2.54 cm.
12 in.	= 1 foot (ft.)	= 30.48 cm.
3 ft.	= 1 yard (yd.)	= 0.9144 m.
5½ yd.	= 1 rod (rd.)	= 5.0292 m.
	or 1 perch (p.)	
	or 1 pole (p.)	
40 rd., or 1/8 mi.	= 1 furlong (fur.)	= 201.168 m.
5,280 ft.	= 1 statute mile (mi.)	= 1.6093 km.
3 mi.	= league	= 4.8280 km.

Linear Measure--Surveyor's, or Gunter's Chain

		(United States)
	1 link (li.)	= 7.92 in.
100 li.	= 1 chain (ch.)	= 66 ft.
10 ch.	= 1 furlong (fur.)	= 660 ft.
8 fur.	= 1 statute mile (mi.)	= 5,280 ft.

Linear Measure--Engineer's Chain

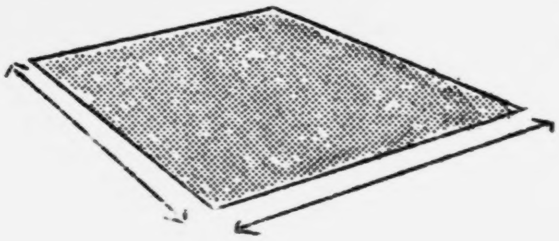
		(United States)
	1 link (li.)	= 1 ft.
100 li.	= 1 chain (ch.)	= 100 ft.
52.8 ch.	= 1 mile (mi.)	= 5280 ft.

Linear Measure--Nautical

		(United States)
	1 span	= 9 in.
8 spans	= 1 fathom (fm.)	= 6 ft.
120 fathoms	= 1 cable's length	= 720 ft.
10 cables' lengths	= 1 nautical mile	= 6,080.20 ft.
	or 1 sea mile	or 1.1516 statute mi.
	or 1 geographic mile	(Former Value)
	1 nautical mile	= 6,076.10333 ft.
	or 1 international mile	= (New Value)
3 nautical miles	= 1 league	= 3.45 statue mi.
60 nautical miles	= 1 degree	= 69.169 statute mi.

Square Measure

Square measure deals with two dimensions--length and width. It expresses the area of a surface. Square measure uses many of the units used in linear measure. In the metric system, a small figure 2 placed to the right and above the abbreviation shows that the measurement is squared.



Square Measure--Metric System

		(United States)
	1 square millimeter (mm^2.)	= 0.002 sq. in.
100 mm^2.	= 1 square centimeter (cm^2.)	= 0.1549 sq. in.
100 cm^2.	= 1 square decimeter (dm^2.)	= 15.499 sq. in.
100 dm^2.	= 1 square meter (m^2.)	= 1,549 sq. in.
100 m^2.	= 1 square decameter (dkm^2.)	= 119.6 sq. yd.
100 dkm^2.	= 1 square hectometer (hm^2.)	= 2.4710 A.
100 hm^2.	= 1 square kilometer (km^2.)	= 247.104 A. or 0.3861 sq. mi.

Land Measure

	1 centiare (ca.)	= 1,549 sq. in.
100 ca.	= 1 are (a.)	= 119.6 sq. yd.
100 a.	= 1 hectare (ha.)	= 2.4710 A.
100 ha.	= 1 square kilometer (km^2.)	= 247.104 A. or 0.3861 sq. mi.

Square Measure--United States

		(Metric)
	1 square inch (sq. in.)	= 6.4516 cm^2.
144 sq. in.	= 1 square foot (sq. ft.)	= 0.0929 m^2.
9 sq. ft.	= 1 square yard (sq. yd.)	= 0.8361 m^2.
30¼ sq. yd.	= 1 square rod (sq. rd.)	= 25.293 m^2.
160 sq. rd.	= 1 acre (A.)	= 0.4047 ha.
640 A.	= 1 square mile (sq. mi.)	= 258.9998 ha. or 2.5899 km^2.

Square Measure--Surveyor's

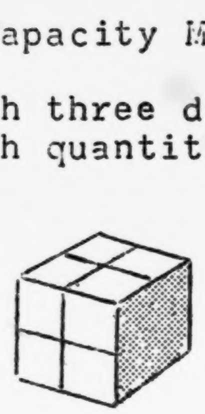
		(United States)
	1 square link (sq. li)	= 62.73 sq. in.
625 sq. li.	= 1 square pole (sq. p.)	= 30.25 sq. yd.
16 sq. p.	= 1 square chain (sq. ch.)	= 484 sq. yd.
10 sq. ch.	= 1 acre (A.)	= 4,840 sq. yd.
640 A.	= 1 section (sec.)	= 1 sq. mi.
36 sec.	= 1 township (tp.)	= 36 sq. mi.

Square Measure--Electric Wire

		(United States)
	1 circular mil	= 0.000000785 sq. in.
1,000 cir. mils	= 1 MCM	= 0.000785 sq. in.
1,000 MCM	= 1 circular inch	= 0.785 sq. in.

Cubic and Capacity Measure

Cubic measure deals with three dimensions--length, breadth, and depth. It expresses such quantities as the amount of space



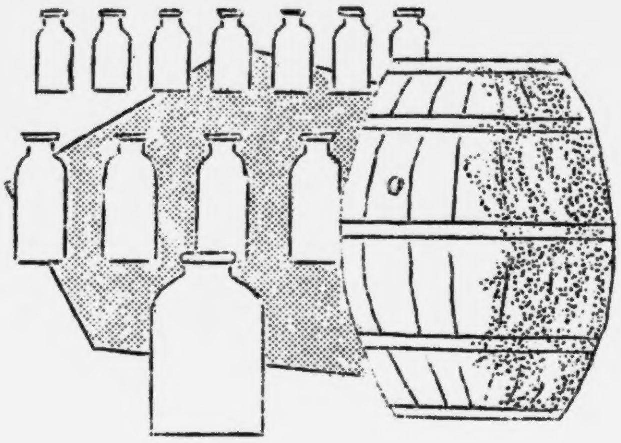
in a box, the amount of wood in a block, or the volume of air in a rubber ball. Cubic measure uses many units used in linear and square measure. In the metric system, a small figure 3 placed to the right and above the abbreviation shows that the measurement is cubed. Capacity measure deals with volumes of certain kinds of materials, for example, liquids or grains.

Cubic Measure--Metric System

			(United States)
	1 cubic millimeter (mm^3.)	=	0.00006 cu. in.
1,000 mm^3.	= 1 cubic centimeter (cm^3.)	=	0.0610 cu. in.
1,000 cm^3.	= 1 cubic decimeter (dm^3.)	=	0.0353 cu. ft.
1,000 dm^3.	= 1 cubic meter (m^3.)	=	1.3079 cu. yd.
1,000 m^3.	= 1 cubic decameter (dkm^3.)	=	1,307.9 cu. yd.
1,000 dkm^3.	= 1 cubic hectometer (hm^3.)	=	1,307,900 cu. yd.

Capacity Measure--Metric System

			(United States)
	1 milliliter (ml.)	=	0.0610 cu. in.
10 ml.	= 1 centiliter (cl.)	=	0.6102 cu. in.
10 cl.	= 1 deciliter (dl.)	=	6.1025 cu. in.
10 dl.	= 1 liter (l.)	=	61.025 cu. in.
		or	1.057 qt. (liquid)
		or	0.908 qt. (dry)
10 l.	= 1 decaliter (dkl.)	=	610.25 cu. in.
10 dkl.	= 1 hectoliter (hl.)	=	6,102.50 cu. in.
10 hl.	= 1 kiloliter (kl.)	=	35.315 cu. ft.
		or	264.178 gal. (liquid)
		or	28.38 bu. (dry)



Liquid Capacity Measure--United States

			(Metric)
	1 gill (gi.)	=7.219 cu. in.	= 0.1183 l.
4 gi.	= 1 pint (pt.)	=28.875 cu. in.	= 0.4732 l.
2 pt.	= 1 quart (qt.)	=57.75 cu. in.	= 0.9463 l.
4 qt.	= 1 gallon (gal.)	=231 cu. in.	= 3.7853 l.
31.5 gal.	= 1 barrel (liquids)(bbl.)		= 119.24 l.
42 gal.	= 1 barrel (petroleum) (bbl.)		= 158.98 l.

Liquid Capacity Measure--Great Britain and Canada

1.2009 U.S. qt. = 1 imperial quart = 69.3185 cu. in.
1.201 U.S. gal. = 1 imperial gallon = 277.420 cu. in.

Dry Capacity Measure--United States

(Metric)
1 pint (pt.) = 33.600 cu. in. = 0.5506 l.
2 pt. = 1 quart (qt.) = 67.20 cu. in. = 1.1012 l.
8 qt. = 1 peck (pk.) = 537.61 cu. in. = 8.8096 l.
4 pk. = 1 bushel (bu.) = 2,150.42 cu. in. = 35.2383 l.
1 barrel (bbl.) = 7,056 cu. in. = 115.62 l.

Dry Capacity Measure--Great Britain and Canada

1.0320 U. S. qt. = 1 dry quart = 69.354 cu. in.
1.032 U. S. bu. = 1 imperial bushel = 2,219.360 cu. in.

Capacity Measure--Household

1 teaspoon = 1/6 fl. oz.
3 teaspoons = 1 tablespoon = 1/2 fl. oz.
16 tablespoons = 1 cup = 8 fl. oz.
2 cups = 1 pint
2 pints = 1 quart
4 quarts = 1 gallon

Capacity Measure--Shipping

(United States)
1 barrel bulk = 5 cu. ft.
8 barrels bulk = 1 shipping ton = 40 cu. ft.
or 1 measurement ton
or 1 freight ton
1 displacement ton = 35 cu. ft.
1 register ton = 100 cu. ft.

Apothecaries' Fluid Measure

(Metric)
1 minim or drop (min. or ♏) = 0.0616 ml.
60 min. = 1 fluid dram (fl. dr. or f ʒ) = 3.6966 ml.
8 fl. dr. = 1 fluid ounce (fl. oz. or f ℥) = 0.0295 l.
16 fl. oz. = 1 pint (O.) = 0.4732 l.
8 O. = 1 gallon (C.) = 3.7853 l.

Wood Measure--Metric System

	(United States)
1 millistere (ms.)	= 0.0353 cu. ft.
10 ms. = 1 centistere (cs.)	= 0.3531 cu. ft.
10 cs. = 1 decistere (ds.)	= 3.5314 cu. ft.
10 ds. = 1 stere (s.)	= 1.3079 cu. yd. or 0.2759 cord
10 s. = 1 decastere (dks.)	= 13.079 cu. yd.
10 dks.= 1 hectostere (hs.)	= 130.8 cu. yd.

Wood Measure--United States

144 cu. in. (1' x 1' x 1")	= 1 board foot (bd. ft.)	= .00236 m^3 or s^3
16 cu. ft. (4' x 4' x 1')	= 1 cord foot (cd. ft.)	= .4528 m^3 or s^3
8 cd. ft. (4' x 4' x 8')	= 1 cord (cd.)	= 3.625 m^3 or s^3

Weight

Weight measures deal with the heaviness of various materials. Avoirdupois weight measures ordinary materials. Troy weight measures precious metals, such as gold and silver, and gems. Apothecaries' weight measures drugs and medicines. All three weight systems--avoirdupois, troy, and apothecaries'--use the same basic unit--the grain.

Metric System Weight

	(Avoirdupois)
1 milligram (mg.)	= 0.0154 gr.
10 mg. = 1 centigram (cg.)	= 0.1543 gr.
10 cg. = 1 decigram (dg.)	= 1.5432 gr.
10 dg. = 1 gram (g.)	= 15.4323 gr.
10 g. = 1 decagram (dkg.)	= 0.3527 oz.
10 dkg. = 1 hectogram (hg.)	= 3.5274 oz.
10 hg. = 1 kilogram (kg.)	= 2.2046 lb.
10 kg. = 1 myriagram (myg.)	= 22.046 lb.
10 myg. = 1 quintal (q.)	= 220.46 lb.
10 q. = 1 metric ton (M. T.)	= 2,204.62 lb.

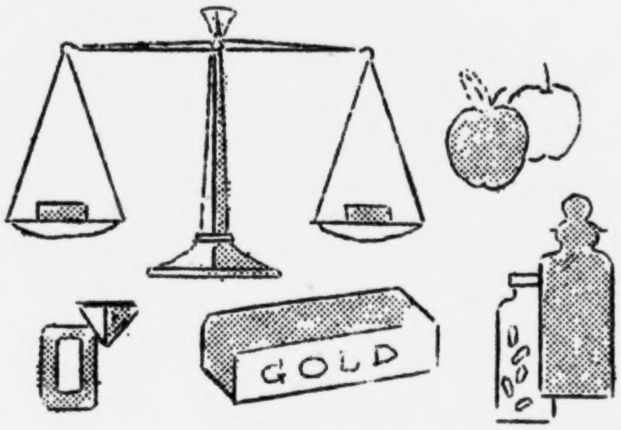
Avoirdupois Weight

	(Metric)
1 grain (gr.)	= 0.0648 g.
27.343,75 gr. = 1 dram (dr.)	= 1.7718 g.

16 dr. = 1 ounce (oz.) = 28.3495 g.
16 oz. = 1 pound (lb.) = 453.5924 g.
or 0.4536 kg.
100 lb. = 1 hundredweight (cwt.) = 45.3592 kg.
2,000 lb. = 1 short ton (s.t.) = 907.18 kg.
or 0.9072 M.T.

Special British Units

14 lb. = 1 stone (st.) = 6.35 kg.
112 lb. = 1 hundredweight (cwt.) = 50.80 kg.
2,240 lb. = 1 long ton (l.t.) = 1,016.05 kg.
or 1.0160 M.T.



Troy Weight

(Metric)
1 grain (gr.) = 0.0648 g.
3.086 gr. = 1 carat (c.) = 0.2 g.
24 gr. = 1 pennyweight (dwt.) = 1.55 g.
20 dwt. = 1 ounce (oz. t.) = 31.1035 g.
12 oz. = 1 pound (lb. t.) = 373.24 g.
or 0.3732 kg.

Apothecaries' Weight

(Metric)
1 grain (gr.) = 0.648 g.
20 gr. = 1 scruple (s. ap. or ℈) = 1.296 g.
3 s. ap. = 1 dram (dr. ap. or ʒ) = 3.888 g.
8 dr. ap. = 1 ounce (oz. ap. or ℥) = 31.1035 g.
12 oz. ap. = 1 pound (lb. ap. or ℔) = 373.24 g.
or 0.3732 kg.

Circular and Angular Measure

1 second (") = $\frac{1}{1,296,000}$ circle

60 seconds = 1 minute (') = $\frac{1}{21,600}$ circle

60 minutes = 1 degree (°) = $\frac{1}{360}$ circle
90 degrees = 1 quadrant or 1 right angle = $\frac{1}{4}$ circle
4 quadrants = 1 circumference = 1 circle

Radians

1° = 0.017454 radians (rad.)
57.2958° = 1 radian
360° = 2π radians

Gunnery

360° = 6,400 mils

Counting Measure

1 dozen (doz.) = 12 units
12 doz. = 1 gross (gr.) = 144 units
12 gr. = 1 great gross = 1,728 units

Paper Measure

24 or 25 sheets = 1 quire (qr.)
20 quires = 1 ream (rm.)
516 sheets = 1 perfect ream
2 reams = 1 bundle (bdl.)
5 bundles = 1 bale